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PROTOTYPE CLUSTER PARACHUTE RECOVERY SYSTEM FOR A 50,000-POUND UNIT LOAD. VOLUME II. DIRECT DESIGN ASPECTS

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Manchester, Connecticut

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PROTOTYPE CLUSTER-PARACHUTE RECOVERY SYSTEM FOR A 50,000-lb UNIT LOAD
VOLUME II- DIRECT DESIGN ASPECTS

by

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Natick, Massachusetts 01760

FOREWORD

This work was initiated in an effort toward the design and fabrication of a prototype recovery parachute assembly to enable the airdrop, by use of parachutes in a cluster, of a 50,000-lb unit load. The first phase of this study was concerned solely with the design aspects; the second phase dealt with fabrication.

Volume II presents the results of work on the direct design of the selected prototype parachute assembly.

This work was conducted under U. S. Army Project 1F162203D-195, Exploratory Development of Airdrop Systems, by Pioneer Parachute Company, Manchester, Connecticut, under contract DAAG17-68-0142.

The project engineer was Mr. Royce A. Toni of the contracting agency. The work was performed under the direction of Mr. Arthur W. Claridge, the project engineer for the U. S. Army Natick Laboratories.

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ABSTRACT

This report covers the direct design aspects of the selected prototype cargo recovery assembly for airdropping heavy unit loads in the order of 50,000 pounds.

The detailed design of the components is covered as well as stress analysis to determine the margins of safety for the materials selected. Material lists and weights for the components are provided. Laboratory testing of individual components and strength efficiency of stitch patterns are shown.

1. INTRODUCTION

The prototype parachute assembly shown in Fig. 1 represents a system that, when used in a cluster of six, will enable the airdrop of a 50,000-lb unit load. This particular configuration was ultimately selected on the basis of findings presented in Volume I of this series.

As a result of the Volume I study, these aspects deal primarily with detail. The purpose of Volume II is to present the results associated with the direct design aspects.

2. SPECIFICATIONS

a. Design

The parachute system was designed to meet all the requirements stated in Volume I, Section 3.

(1) Parachute Size

The procedure followed to determine the size of the parachute system (135-ft-D_o) is presented in Volume I, Section 9.

(2) Opening Force

The method used to define the maximum force (28,300 lb) experienced by any one parachute when used in a cluster of six to airdrop a 50,000-lb unit load, is presented in Volume I, Section 10.

b. Components

The selected prototype assembly consists of the following components:

(a) canopy, which has the subcomponents

(1) suspension lines,
(2) vent ring, and
(3) center line;

(b) risers, which have the subcomponent

(1) separable link;

(c) riser extension;

(d) suspension clevis, which has the subcomponent

(1) bushing;

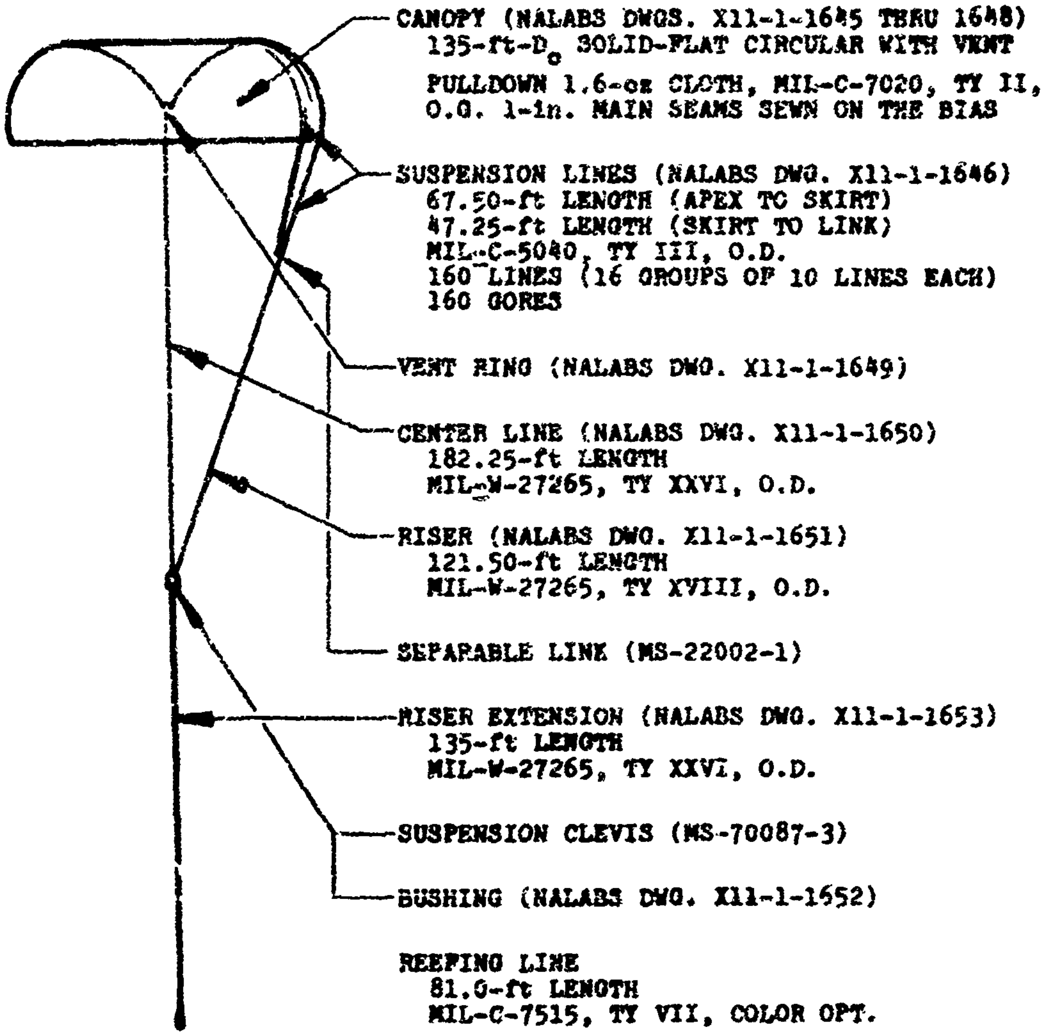


Fig. 1. Prototype assembly selected for use in a cluster of six to airdrop a 50,000-lb unit load.

(e) deployment bag and bridle; and

(f) reefing components.

The canopy is solid-flat circular, having a 135-ft nominal diameter (D_o). The suspension lines are approximately $0.35 \times D_o$ in length, measured from the separable link to the canopy skirt; the lines continue to run through the canopy main seam up to the vent ring and return to the separable link via the adjacent gore.

The center line is of two-ply construction and has a length approximately equal to the total length of the suspension line and its riser plus $D_o/10$.

The risers are approximately $0.65 \times D_o$ in length. At one end are separable links to which the suspension lines can be tied; the other end is looped so as to be accommodated by the clevis. The construction of this item is such that for every four ends connecting to a total of forty suspension lines (10 lines per end) the other (and only) end connects to the clevis.

The riser extension is of 6-ply construction and looped at one end so as to be fitted into the clevis. The other end, the load-attachment point, is looped to accommodate a hardware fitting supplied by Natick Laboratories.

c. Deployment Conditions and Weight

The gross rigged weight for a cluster of six of the specified parachute assemblies is 50,000 lbs. The approximate weight of one parachute assembly, including the deployment bag, is 513 lbs.

When used as a member of a six-parachute cluster, the parachute is capable of opening without structural failure when released at a speed of 223 ft/sec and a dynamic pressure of 76.3 lb/ft^2.

d. Margins of Safety

The margins of safety for structural loads in the above-cited opening environment are positive for all components.

3. GORE LAYOUT

The material used for the canopy of a parachute assembly is usually taken from a roll, which is of a given number of running yards (in length) and of a given number of inches in

width. For a solid-flat circular canopy, the number of gores required normally dictates the width of the fabric. However, for the parachute configuration under design, other considerations dominated, primarily the decision to use Military-Specification materials for all fabric components. To adhere to this requirement for suspension lines, it became necessary to assign to the assembly 160 gores. Therefore, the selected prototype parachute assembly is a 135-ft-nominal-diameter solid-flat circular configuration having 160 gores.

a. Basic Gore Geometry

The geometry associated with a basic gore for a solid-flat circular canopy is depicted in Fig. 2. This geometry is representative of the gore's desired finished dimensions.

The theoretical length of the gore is given by

$$R = D_o/2. \tag{3-1}$$

The vent radius can be expressed as a fraction of the theoretical gore length. Hence,

$$V_R = aR. \tag{3-2}$$

The angle subtended by the intersection of the two theoretical lengths of the gore at the parachute's theoretical center is simply defined by

$$2\phi = \frac{360}{2N} , \tag{3-3}$$

where N is the number of gores comprising the particular configuration.

The widths of the gore at the vent and skirt respectively are given by

$$M = 2V_R \sin \phi \tag{3-4}$$

and

$$\bar{O} = 2R \sin \phi. \tag{3-5}$$

The actual length and height of the gore are given, respectively by

$$G = R - V_R \tag{3-6}$$

and

$$T = G \cos \phi. \tag{3-7}$$

Table 1 lists the geometry associated with the basic gore for the prototype parachute assembly under design herein.

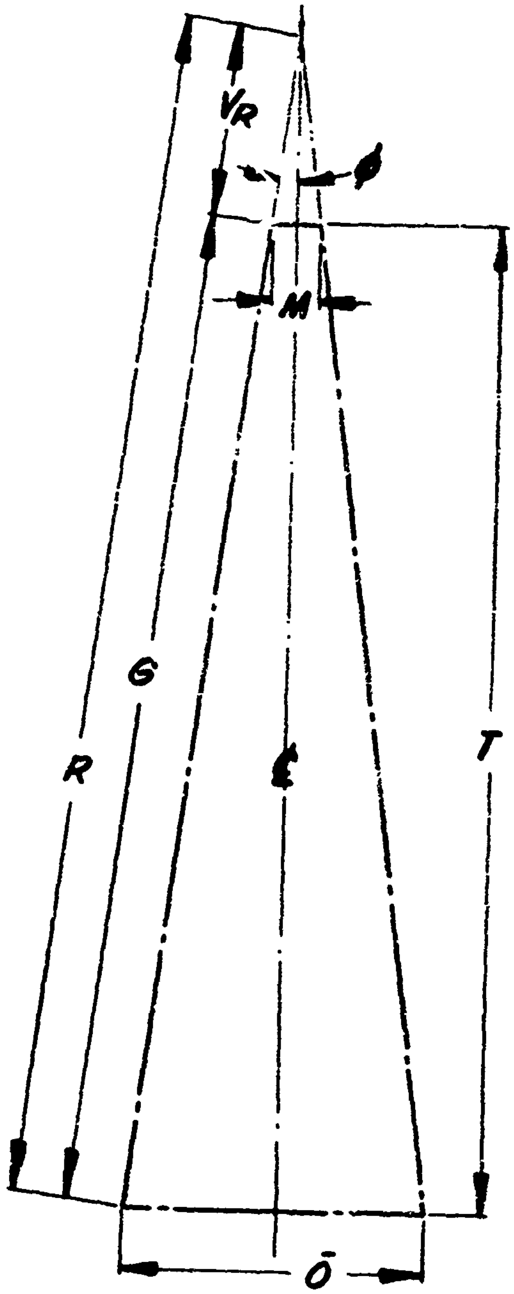


Fig. 2. Geometry associated with a basic gore of a solid-flat circular canopy.

TABLE 1
GEOMETRY
ASSOCIATED WITH
BASIC GORE
OF A 135-ft-D_o

SOLID-FLAT
CIRCULAR CANOPY
OF 160 GORES

a	=	0.04
N	=	160 gores
D_o	=	135 ft
R	=	67.5 ft
V_R	=	32.4 in.
ϕ	=	1°7'30"
M	=	1.272 in.
$\overline{O}$	=	31.801 in.
G	=	64.800 ft
T	=	64.788 ft

b. Fullness and Seam Allowances

The geometry associated with a basic gore, including fullness allowance and seam allowance, for a solid-flat circular canopy is depicted in Fig. 3.

(1) Fullness

The dimensions for the gore widths at the vent and skirt respectively become

$$M_f = M(1 + f_M) \tag{3-8}$$

and

$$\overline{O}_f = \overline{O}\,(1 + f_m), \tag{3-9}$$

where the terms f_m and $f_{\overline{O}}$ represent respective fullness factors.

The dimensions for the gore's actual length and height become respectively

$$G_f = G\,(1 + f_G) \tag{3-10}$$

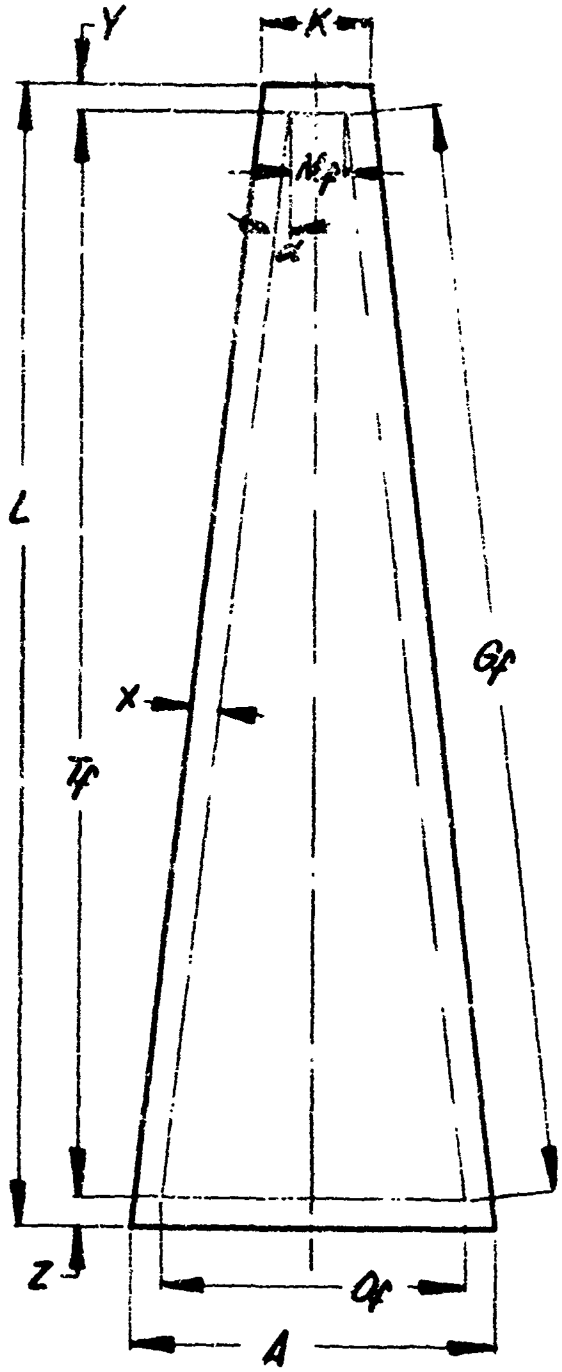


Fig. 3. Geometry associated with a basic gore, including fullness allowance and seam allowance, for a solid-flat circular canopy.

TABLE 2
GEOMETRY
ASSOCIATED WITH
BASIC GORE,
INCLUDING FULL-
NESS ALLOWANCE,
FOR A 135-ft-D_o

SOLID-FLAT
CIRCULAR CANOPY
OF 160 GORES

f_m = 0.10
$f_{\overline{O}}$ = 0.0
f_G = 0.0
M_f = 1.399 in.
$\overline{O}_f$ = 31.801 in.
G_f = 64.800 ft
T_f = 64.788 ft
α = 1°7'0"

and

$$T_f = G_f \cos \alpha, \tag{3-11}$$

where the term f_G represents a fullness factor and

$$\alpha = \sin^{-1} \frac{\overline{O}_f - M_f}{2G_f}. \tag{3-12}$$

Table 2 lists the geometry associated with the basic gore, including the fullness allowance, for the prototype parachute assembly under design herein.

(2) Seams

The dimensions for the gore's widths at the vent and skirt become respectively

$$K = M_f + 2\left(\frac{X}{\cos \alpha} + Y \tan \alpha\right) \tag{3-13}$$

$$A = \overline{O}_f + 2\left(\frac{X}{\cos \alpha} + Z \tan \alpha\right), \tag{3-14}$$

TABLE 3
GEOMETRY
ASSOCIATED WITH
BASIC GORE,
INCLUDING FULL-
NESS ALLOWANCE
AND SEAM
ALLOWANCE, FOR
A 135-ft-D_o

SOLID-FLAT
CIRCULAR
CANOPY
OF 160 GORES

X =	1.5 in.
Y =	2.0 in.
Z =	2.0 in.
K =	4.322 in.
A =	34.879 in.
L =	65.121 ft

where the term X represents the seam allowance along the gore's length and Y and Z represent the seam allowance at the gore's two widths.

The dimension for the gore's height becomes

$$L = T_f + Y + Z. \tag{3-15}$$

Table 3 lists the geometry associated with the basic gore, including the fullness allowance and the seam allowance, for the prototype parachute assembly under design.

c. Panels Within the Gore

Owing to the size of a gore, it sometimes becomes impractical to design it as a solid piece of cloth. As a result, the gore must be designed so as to be comprised of panels. Figure 4 depicts the geometry associated with a gore comprised of n panels for a solid-flat circular canopy fabricated from a roll of cloth 36.5 inch wide.

The number of panels comprising the gore can be determined by the expression

$$n = \frac{L - S_1}{S} + 2; \tag{3-16}$$

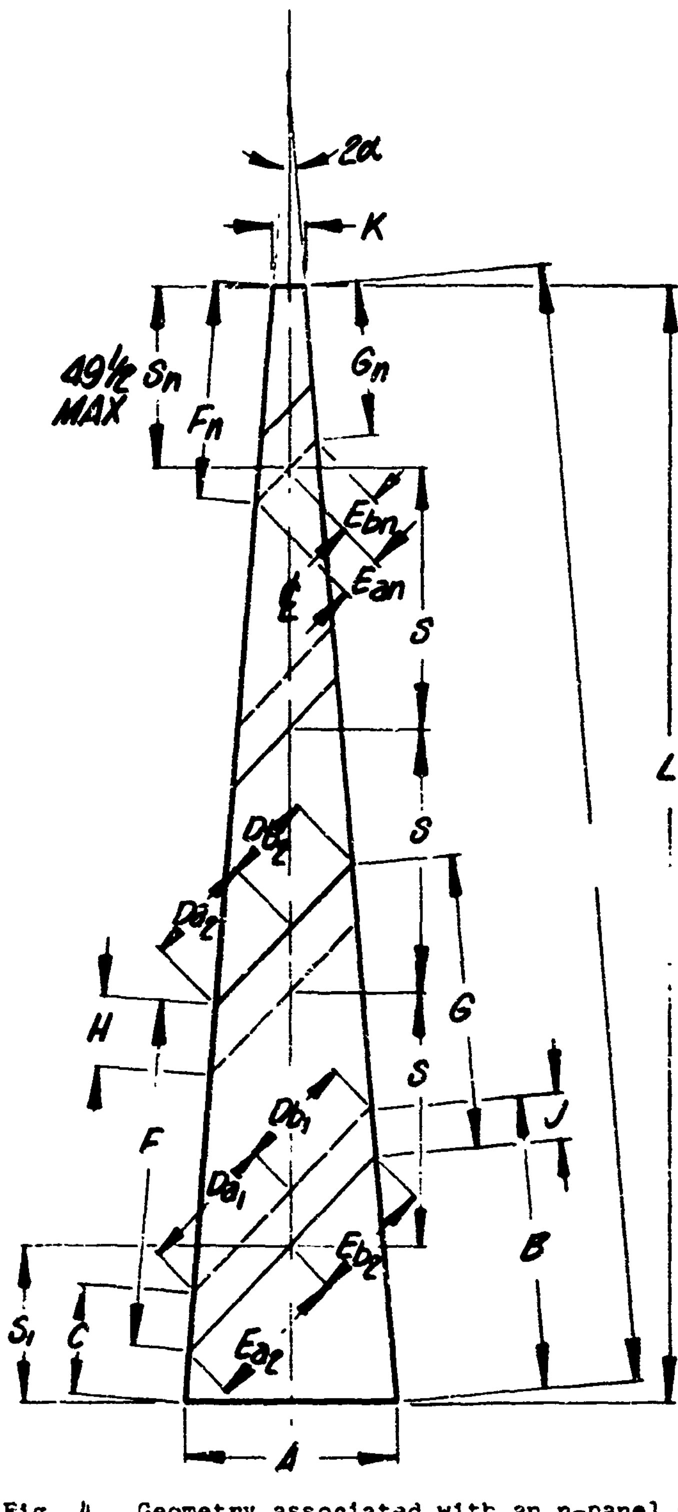


Fig. 4. Geometry associated with an n-panel gore of solid-flat circular canopy, fabricated from a 36.5-in.-wide roll of cloth.

for a 36.5-in.-width fabric and a 1.5-in. seam allowance (X is 1.5 in.),

$$S = 49.498 \text{ in.} \tag{3-17}$$

and

$$S_1 = U_1 - 2.121 \text{ in.}, \tag{3-18}$$

where

$$U_1 = 51.618 \text{ in.} - \tfrac{1}{2}A. \tag{3-19}$$

(1) The First Panel

The geometry associated with the first panel of a gore comprised of n panels for a solid-flat circular canopy fabricated from a 36.5-in.-wide roll of cloth is depicted in Fig. 5. Referring to this figure, it can be seen that

$$\beta = 45^\circ + \alpha, \tag{3-20}$$

$$\gamma = 45^\circ - \alpha, \tag{3-21}$$

$$U_1 = 51.618 - \tfrac{1}{2}A, \tag{3-19}$$

$$S_1 = U_1 - 2.121, \tag{3-18}$$

$$B = \frac{36.5}{\sin \beta}, \tag{3-22}$$

and, finally,

$$c = \frac{36.5 - 0.707A}{\sin \gamma}. \tag{3-23}$$

Now it is possible to present the expressions for the first panel's geometry, that is

$$D_{a_1} = 0.707A - \frac{C \sin \alpha}{0.707} \tag{3-24}$$

and

$$D_{b_1} = 0.707A - \frac{51.618 \sin \alpha}{\sin \beta}. \tag{3-25}$$

The geometry associated with the first panel of the gore for the canopy under design is listed in Table 4(b).

(2) The Second Panel Through the (n - 1) st Panel

The geometry associated with the second panel through the (n - 1)st panel of a gore comprised of n panels for a solid-flat circular canopy fabricated from a 36.5-in.-wide roll of cloth is depicted in Fig. 6. Referring to this figure, it can be seen that

$$W = 36.5 \text{ in.}, \tag{3-26}$$

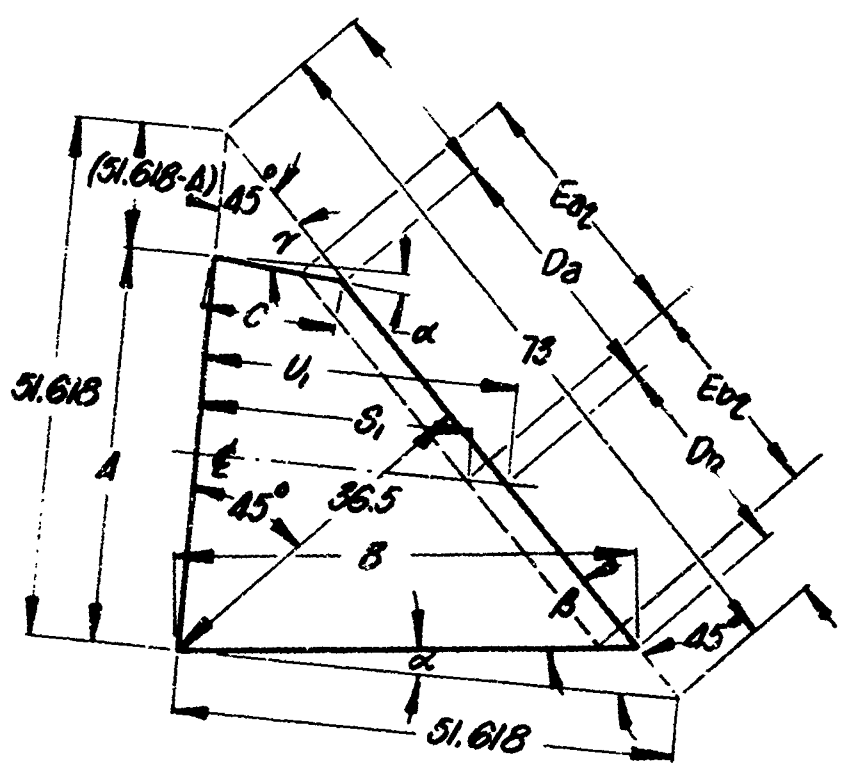


Fig. 5. Geometry associated with the first panel of an n-panel gore of a solid-flat circular canopy, fabricated from a 36.5-in.-wide roll of cloth.

TABLE 4

GEOMETRY ASSOCIATED WITH PANELS COMPRISING A SINGLE GORE OF A 160-GORE, 135-ft-D_o, SOLID-FLAT CANOPY FABRICATED FROM 36.5-in. CLOTH USING A 1.5-in. SEAM ALLOWANCE

(a) Defined Parameters

n	=	17 panels	C	=	17.076 in.
S	=	49.498 in.	W	=	36.5 in.
S_1	=	32.057 in.	F	=	52.655 in.
V_1	=	34.178 in.	G	=	50.642 in.
β	=	46°7'0"	H	=	2.164 in.
γ	=	43°53'0"	J	=	2.081 in.
B	=	50.642 in.	V	=	51.618 in.

(b) Panel Geometry*

Panel	E_a	E_b	D_a	D_b	F	G	S
1	-	-	24.191	23.263	-	-	32.057
2	24.251	23.321	22.796	21.921	9.278	4.681	49.498
3	22.855	21.979	21.400	20.579	9.278	4.681	49.498
4	21.460	20.636	20.004	19.236	9.278	4.681	49.498
5	20.064	10.294	18.608	17.894	9.278	4.681	49.498
6	18.660	17.951	17.212	16.551	9.278	4.681	49.498
7	17.272	16.609	15.816	15.209	9.278	4.681	49.498
8	15.876	15.266	14.421	13.866	9.278	4.681	49.498
9	14.430	13.924	13.025	12.524	9.278	4.681	49.498
10	13.085	12.581	11.629	11.181	9.278	4.681	49.498
11	11.689	11.239	10.233	9.839	9.278	4.681	49.498
12	10.293	9.896	8.837	8.496	9.278	4.681	49.498
13	8.897	8.554	7.441	7.154	9.278	4.681	49.498
14	7.501	7.211	6.046	5.811	9.278	4.681	49.498
15	6.105	5.869	4.650	4.469	9.278	4.681	49.498

(continued on next page)

(b) Panel Geometry* (continued)

Panel	E_a	E_b	D_a	D_b	F	G	S
16	4.710	4.527	3.254	3.127	9.278	4.681	49.498
17	3.314	3.184	-	-	9.278	4.681	6.932

*Entries are in inches.

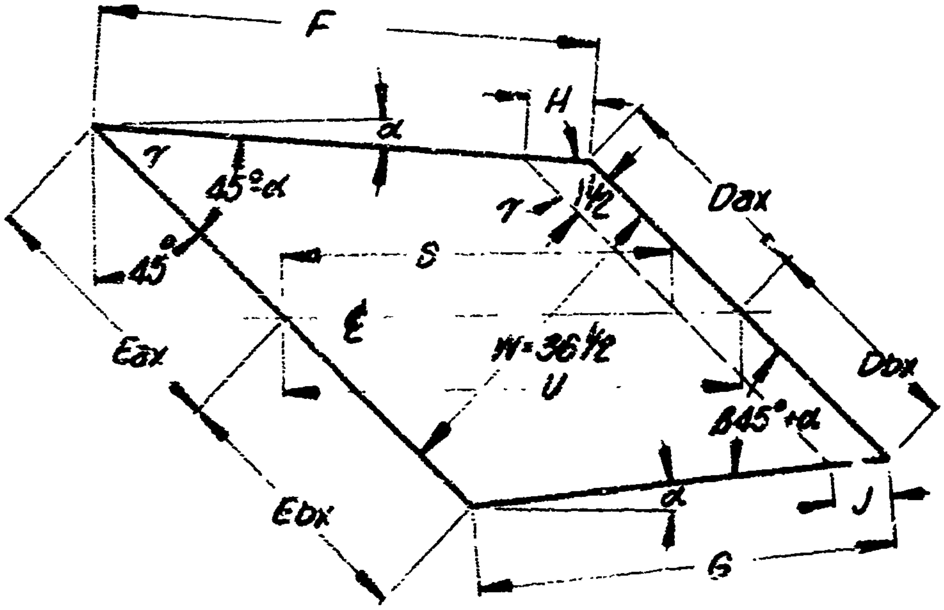


Fig. 6. Geometry associated with the 1st through the (n - 1)st panels of an n-panel gore of a solid-flat circular canopy, fabricated from a 36.5-in.-wide roll of cloth.

$$F = \frac{W}{\sin \gamma} , \tag{3-27}$$

$$G = \frac{W}{\sin \beta} , \tag{3-28}$$

$$H = \frac{1.5}{\sin \gamma} , \tag{3-29}$$

$$J = \frac{1.5}{\sin \beta} , \tag{3-30}$$

$$S = 49.498 \text{ in.}, \tag{3-17}$$

and

$$U = 51.618 \text{ in.} \tag{3-31}$$

The expressions for the second panel's geometry are as follows.

$$E_{a_2} = D_{a_1} + \frac{2.121 \sin \alpha}{\sin \gamma} , \tag{3-32}$$

$$E_{b_2} = D_{b_1} = \frac{2.121 \sin \alpha}{\sin \beta} , \tag{3-33}$$

$$D_{a_2} = D_{a_1} = \frac{49.498 \sin \alpha}{\sin \gamma}, \tag{3-34}$$

and

$$D_{b_2} = D_{b_1} - \frac{49.498 \sin \alpha}{\sin \beta}. \tag{3-35}$$

Finally, the general expressions for the geometry of the remaining panels (not including the nth panel) are

$$E_{a_x} = E_{a_2} - (x - 2) \frac{49.498 \sin \alpha}{\sin \gamma}, \tag{3-36}$$

$$E_{b_x} = E_{b_2} - (x - 2) \frac{49.498 \sin \alpha}{\sin \beta}, \tag{3-37}$$

$$D_{a_x} = D_{a_1} - (x - 1) \frac{49.498 \sin \alpha}{\sin \gamma}, \tag{3-38}$$

and

$$D_{b_x} = D_{b_1} - (x - 1) \frac{49.498 \sin \alpha}{\sin \beta}. \tag{3-39}$$

It should be cited that the subscript x in the above equations refers to the panel number. The limits of x in these equations are given by

$$2 \le x \le n - 1. \tag{3-40}$$

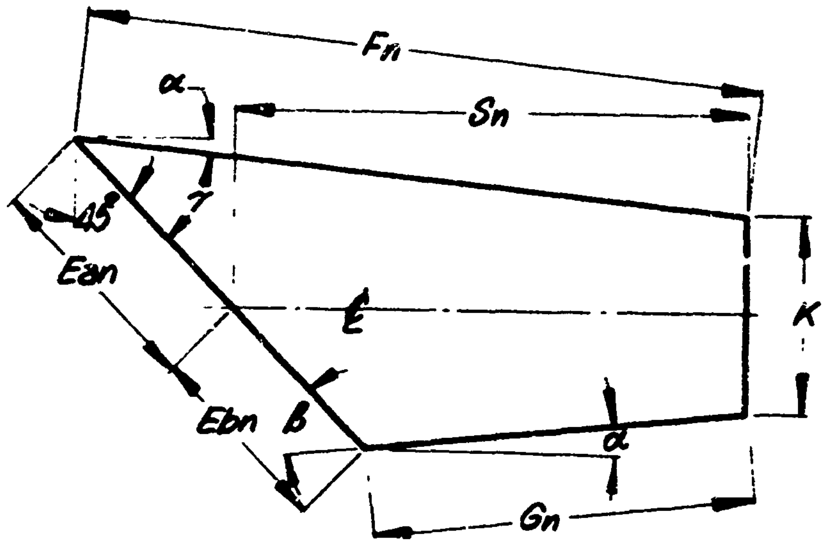


Fig. 7. Geometry associated with the nth panel of an n-panel gore of a solid-flat circular canopy, fabricated from a 36.5-in.-wide roll of cloth.

The geometry associated with the first panel through the (n - 1)st panel of the gore for the canopy under design is listed in Table 4(b).

(3) The nth Panel

The geometry associated with the nth panel of a gore comprised of n panels for a solid-flat circular canopy fabricated from a 36.5-in.-wide roll of cloth is depicted in Fig. 7. Referring to this figure, it can be seen that the panel geometry is calculated from the following expressions.

$$E_{a_n} = E_{a_2} - (n - 2) \frac{49.498 \sin \alpha}{\sin \gamma}, \tag{3-41}$$

$$E_{b_n} = E_{b_2} - (n - 2) \frac{49.498 \sin \alpha}{\sin \beta} \tag{3-42}$$

$$F_n = \frac{0.707 (S_n + \frac{1}{2}K)}{\sin \gamma}, \tag{3-43}$$

$$G_n = \frac{0.707 (S_n - \frac{1}{2}K)}{\sin \beta}, \tag{3-44}$$

and

$$S_n = L - S_1 + S (n - 2). \tag{3-45}$$

The geometry associated with the nth panel of the gore for the canopy under design herein is listed in Table 4(b).

4. STRESS ANALYSIS

The purpose of the stress analysis is to establish the margins of safety for the materials selected for use in the prototype parachute assembly. These margins are calculated for the worst-case loading environment; for this particular assembly, such a condition occurs when the assembly is used as a member of a six-parachute cluster to airdrop a 50,000-lb unit load from an aircraft traveling at 223 ft/sec and under a 76.3-lb/ft^2 dynamic pressure. The maximum reefed opening force experienced by an individual assembly for such an operational environment is 28,300 lb; the method for arriving at this maximum is presented in Volume I, Section 10.

The procedure followed for calculating the margins of safety is, first, to calculate the components' allowable load by use of the expression

$$\text{allow load} = \frac{\text{ult strength}}{\text{overall design factor}} . \tag{4-1}$$

The ultimate strength is taken from the average of five control samples tested to their ultimate. This is presented in Appendix A. The overall design factor is arrived at by the considerations accounted for in Table 5.

Now, the margin of safety becomes simply

$$M.S. = \frac{\text{allow load}}{\text{worst-case load}} - 1. \qquad (4-2)$$

The margins of safety calculated for the components of the selected prototype parachute assembly are summarized in Fig. 8.

a. Maximum Canopy Stress for a Vent-pulldown Parachute

With regard to the parachute canopy, it must be pointed out that the establishment of a stress theory is extremely difficult owing to the very nature of the structure. It is a flexible device, constructed from a fabric, and operates in a highly dynamic mode. Therefore, as far as stress analysis is concerned, it is not necessary to attempt to conduct a high-order analytical study. Rather, some basic assumptions were used that, when coupled with experience and intuition, lead to "ball-park" results.

Use of the vent pulldown leads to opening-shape characteristics that somewhat deviate from those normally associated with the standard parachute. This is indicated by a study of movie film depicting deployments of single and clustered G-11A vent pulldowns from an above-terrain altitude of 1500 ft and a release velocity of 150 knots. The general opening shape for all the canopies in these drops is depicted in Fig. 9. This shape is most definitive at or just following full reef, the point at which the parachute loads are at maximum.

Figure 9 shows that, at full reef, the canopy exhibits prominent domes ("false vents"). The true vent is, of course, pulled down within the skirt area. Therefore, there is no physical means for the canopy to bleed off pressure. This accounts for the relatively quick opening and resulting high loads associated with the vent-pulldown parachute.

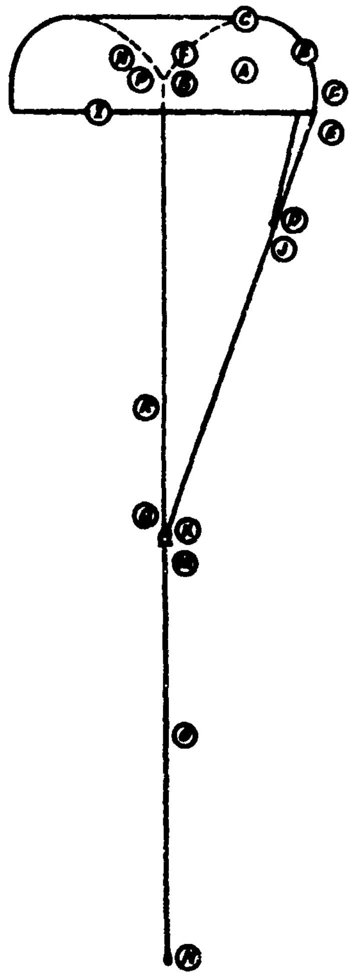
(1) G-11A Cargo Parachute

The G-11A cargo parachute under discussion here has a reefing ratio of 20%; that is, $D_R = 0.2D_O$. This then implies that, at reefed state, the parachute diameter is 20 ft. Figure 10 shows the results of scaling from the frames of the previously mentioned movie film. As can be observed, the scaling was reasonably accurate. Therefore, from this

TABLE 5
VARIOUS CONSIDERATIONS FOR ARRIVING AT OVERALL DESIGN FACTOR

Item	Consideration						Design factor, cf/mlk	Overall design factor, jcf/mlk
	Safety,[1] j	Line convergence,[2] c	Asymmetrical load,[3] f	Joint eff.,[4] m	Abrasion,[5] l	Fatigue,[2] k		
Canopy								
Cloth	2.00	N/A	1.05	1.00	0.96	0.95	1.15	2.30
Main seam	2.00	N/A	1.05	0.98	0.96	0.95	1.18	2.36
Cross seam	2.00	N/A	1.05	0.79	0.96	0.95	1.46	2.92
Suspension line								
To con. link	2.00	1.04	1.05	0.97	0.96	0.95	1.24	2.48
To skirt	2.00	1.04	1.05	1.00	0.96	0.95	1.20	2.40
To main seam at skirt and vent	2.00	N/A	1.05	1.00	0.96	0.95	1.15	2.30
To vent ring	2.00	N/A	1.05	0.87	0.96	0.95	1.33	2.66
Reefing line	2.00	N/A	1.05	0.96	1.00	1.00	1.09	2.18
Skirt reinf.	2.00	N/A	1.05	0.99	0.96	0.95	1.17	2.34
Vent reinf.	2.00	N/A	1.05	0.93	0.96	0.95	1.24	2.48
Riser								
To conn. link	2.00	N/A	1.05	0.75	0.96	0.95	1.53	3.06
To clevis	2.00	N/A	1.05	0.88	0.96	0.95	1.31	2.62
[Ri]ser ext.								
To clevis	2.00	N/A	1.05	0.82	0.96	0.95	1.41	2.82
To load attach.	2.00	N/A	1.05	0.87	0.96	0.95	1.34	2.68
Splice	2.00	N/A	1.05	0.88	0.96	0.95	1.31	2.62
Center line								
To vent ring	2.00	N/A	1.05	0.83	0.96	0.95	1.39	2.77
To clevis	2.00	N/A	1.05	0.87	0.96	0.95	1.32	2.64
Splice	2.00	N/A	1.05	0.86	0.96	0.95	1.34	2.68

[1]Vol. I, Sec. 3.0.
[2]Ref. 3, p. 370.
[3]Conventional practice.
[4]App. A; for riser extension, see Fig. 4-14.
[5]Selected on basis of having service life similar to that of the T-10.



Symbol	Item	Margin of safety
	Canopy	
A	Cloth	+1.05
B	Main seam	+0.96
C	Cross seam	0
	Suspension line	
D	To conn. link	+0.35
E	To skirt	+0.39
F	In main seam	+0.38
G	To vent ring	+0.19
H	Vent reinforcing	+0.75
I	Skirt reinforcing	+0.43
	Riser	
J	To conn. link	+0.27
K	To clevis	+0.48
	Riser extension	
M	To clevis	+0.17
N	To load attach.	+0.23
O	Splice	0
	Center line	
P	To vent ring	0
Q	To clevis	+0.04
R	Splice	+0.03

Fig. 8. Summary of the margins of safety.

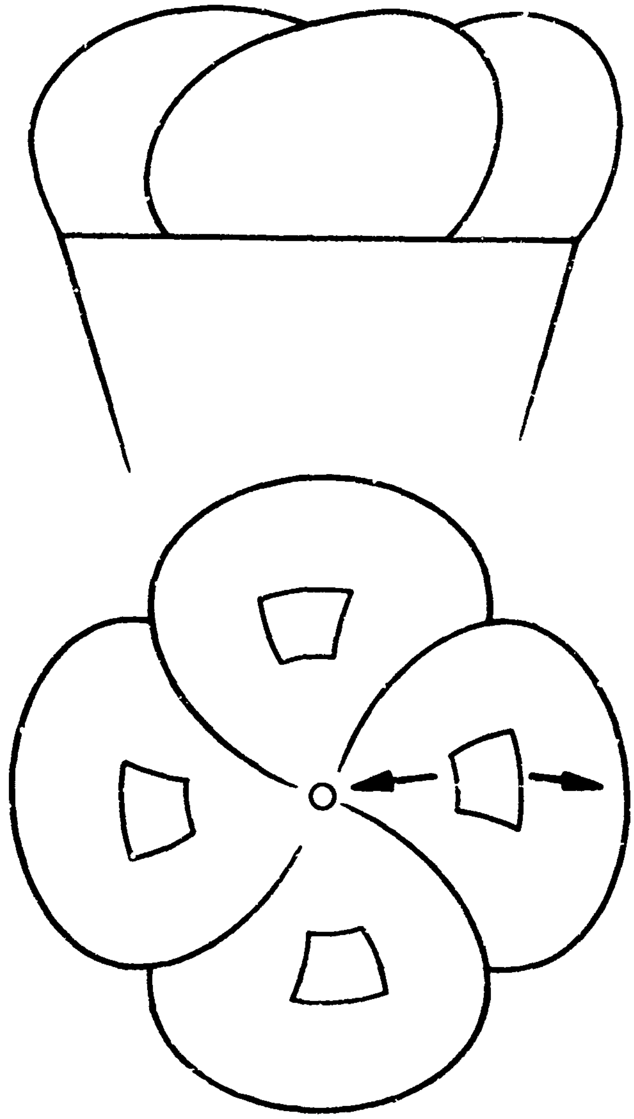


Fig. 9. General shape characteristics associated with the opening of the G-11A vent-pulldown parachute.

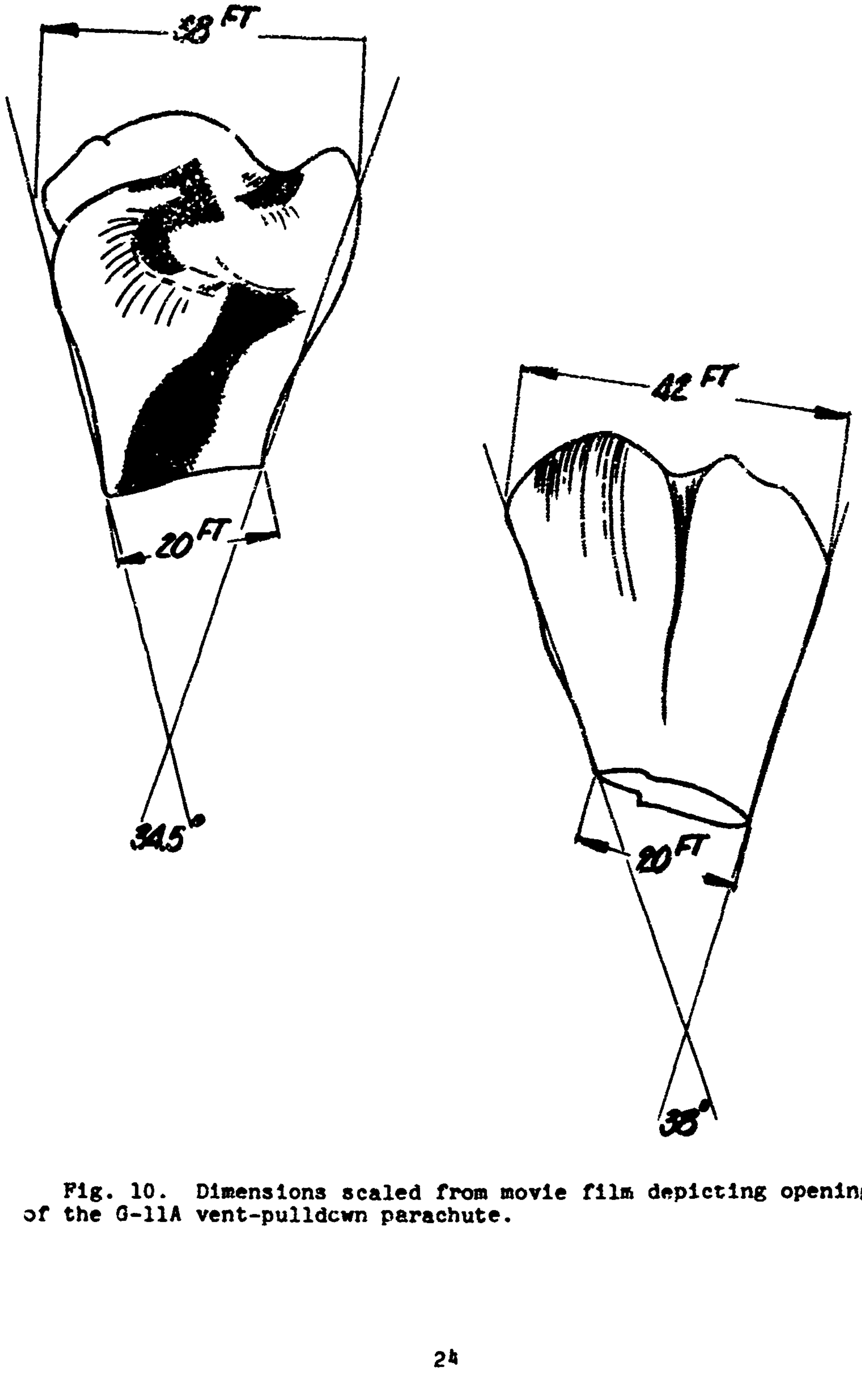


Fig. 10. Dimensions scaled from movie film depicting opening of the G-11A vent-pulldown parachute.

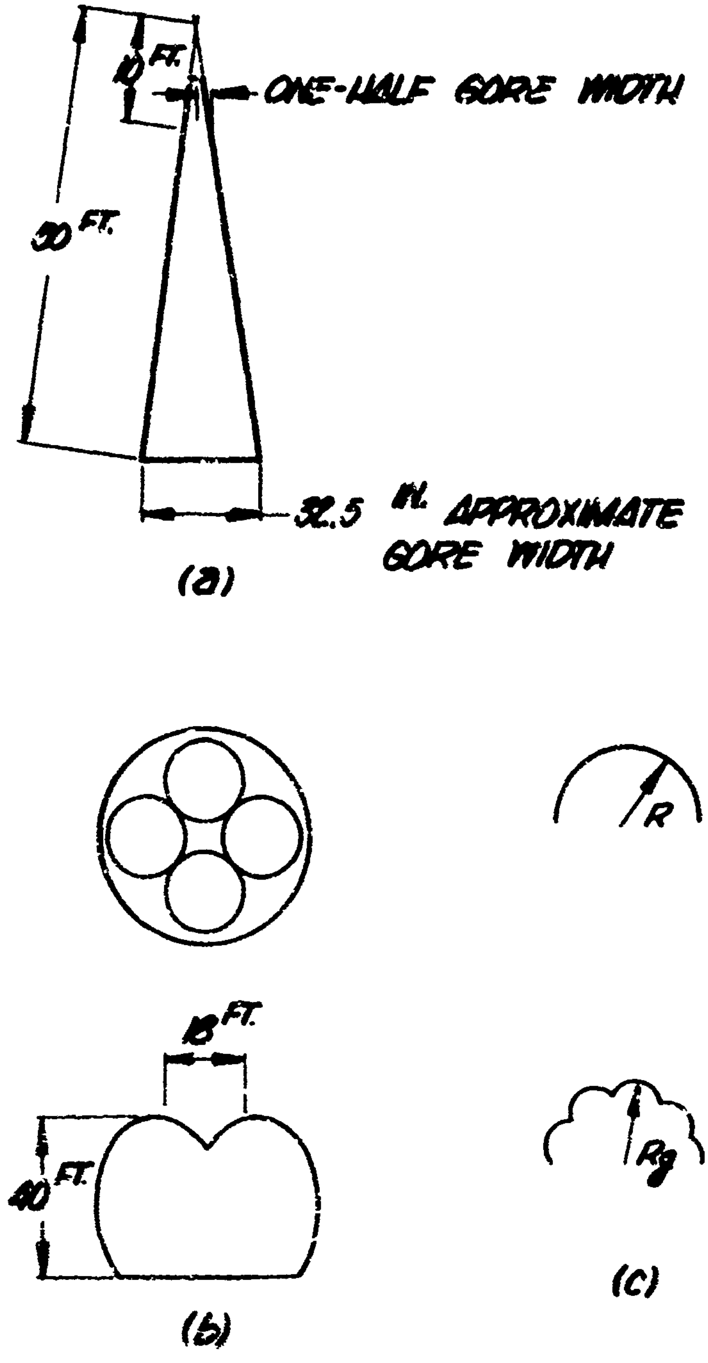


Fig. 11. Approximate dimensions associated with the opening shape of a G-11A vent-pulldown parachute.

figure, it can be established that the high-pressure area of the canopy is located approximately 40 ft from the skirt of the canopy. Figure 11 (a) shows that the width of any individual gore at this location is simply

$$2 \times \frac{10}{50} \times \frac{32.5}{2} = 6.5 \text{ in.} \tag{4-3}$$

Since the canopy has 120 gores, this means that, at the location of the high-pressure areas, the circumference can be calculated to be

$$120 \times 6.5 = 780 \text{ in.} = 65 \text{ ft.} \tag{4-4}$$

From scaling the film, it was determined that the false vents lie on a circumference of a circle whose diameter is approximately 18 ft [see Fig. 11 (b)]. Hence, the circumference is

$$18\pi = 56 \text{ ft.} \tag{4-5}$$

The difference between the above two circumferences is 9 ft. This means that, at the reefed state, there is some 9 ft of fullness, or, for the case of four "false vents," 2.25 ft per false vent. This amounts to some four gores per high-pressure area that have not yet unfolded.

The stress in the canopy is now determined by assuming that each of the high-pressure areas lies on the dome of an 18-ft-diam. hemisphere. Viewed this way, the maximum stress becomes simply the hoop stress; hence,

$$qR = 30 \times 9 = 270 \text{ lb/ft} = 22.4 \text{ lb/in.}, \tag{4-6}$$

where q is the aerodynamic pressure, which El Centro drop-test data reveal to be approximately 30 lb/ft^2 at attainment of full reef.

It can be concluded that the above approach to the maximum canopy stress present in the deployment of a vent-pulldown parachute is conservative because, in practice, the main seams carry a significant portion of the parachute load and consequently cut into the smooth hemisphere. From Fig. 11 (c), it becomes obvious that, since $R_g < R$, the product of q and R is reduced.

(2) Selected Prototype Parachute Assembly (D_o = 135 ft)

For a cluster of six 135-ft-diam. vent-pulldown parachutes, it must be assumed that the high-pressure areas each lie on the dome of a hemisphere whose diameter is

$$0.18 \times 135 = 24.3 \text{ ft} \quad (4\text{-}7)$$

The aerodynamic pressure at the time of maximum cluster load (at or following attainment of full reef) is approximately 28.6 lb/ft^2 (refer to Appendix B). Hence the maximum canopy stress, which is a circumferential stress acting in a direction normal to the main seam, is

$$qR = 28.6 \times 12.15 = 347 \text{ lb/ft} = 29 \text{ lb/in.} \quad (4\text{-}8)$$

Knowing the maximum canopy stress, it is now possible to calculate its margin of safety.

(1 Canopy Cloth

The allowable load on the canopy cloth itself is calculated from Eq. (4-1):

$$\text{allow load} = \frac{136.6 \text{ lb/in.}}{2.30} = 59.4 \text{ lb/in.} \quad (4\text{-}1a)$$

Use of Eq. (4-2) yields a margin of safety of

$$\text{M.S.} = \frac{59.4 \text{ lb/in.}}{29 \text{ lb/in.}} - 1 = +1.05, \quad (4\text{-}2a)$$

where (it should be noted), for the canopy, the worst-case load is the maximum canopy stress.

(2 Canopy Main Seam

The allowable load on the canopy main seam is calculated from use of Eq. (4-1). Hence,

$$\text{allow load} = \frac{134 \text{ lb/in.}}{2.36} = 56.8 \text{ lb/in.} \quad (4\text{-}1b)$$

Use of Eq. (4-2) yields, for the margin of safety

$$\text{M.S.} = \frac{56.8 \text{ lb/in.}}{29 \text{ lb/in.}} - 1 = +0.96. \quad (4\text{-}2b)$$

(3 Canopy Cross Seam

Once more, Eq. (4-1) yields the allowable load, this time for the canopy cross seam:

$$\text{allow load} = \frac{60 \text{ lb/in.}}{2.92} = 20.5 \text{ lb/in.} \quad (4\text{-}1c)$$

Since the cross seam is located on the gore so as to subtend an angle of 45° with the circumerential refer-

ence, and since the canopy stresses in the direction normal to the circumference are assumed negligible, it is permissible to state that the force normal to the cross seam is simply

$$(\text{max canopy stress}) \times \sin 45^\circ$$
$$= (29 \text{ lb/in.}) \times 0.707 = 20.5 \text{ lb/in.} \quad (4\text{-}9)$$

Equation (4-2) leads to the following calculated margin of safety:

$$\text{M.S.} = \frac{20.5 \text{ lb/in.}}{20.5 \text{ lb/in.}} - 1 = 0. \quad (4\text{-}2c)$$

b. Reefing Line

The forces to which the reefing line is subjected are a function of a number of fixed factors: specifically, the number of gores in a parachute, the maximum opening load, and the length of the suspension lines. These forces in turn are functions of certain variables which may not be determined without a drop-test program--such as the most suitable reefing ratio and the inflated shape of the reefed parachute as typified by the angle formed between the tangent to the radial seam at the skirt and a reference parallel to the parachute center line.

(1) Reefing-line Force

Figure 12 depicts the force behavior of the reefing line for a vent-pulldown parachute at the initial stages of full reefed condition. If F_O represents the maximum load, then the force in one suspension line becomes

$$(F_{SL})_{FR} = \frac{F_O}{N \cos \alpha_{FR}} , \quad (4\text{-}10)$$

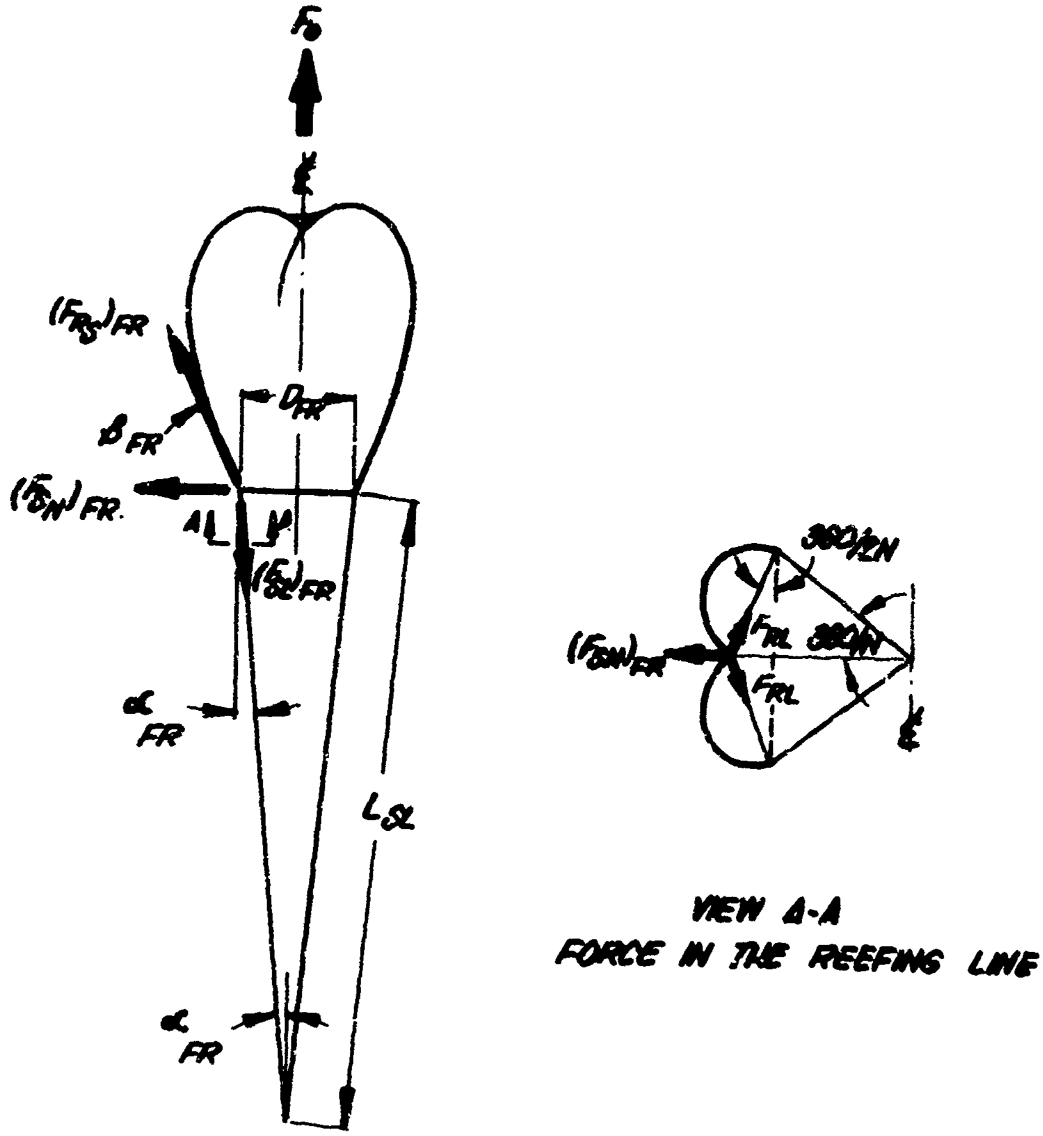
where N is the number of gores comprising the parachute canopy and is also equal to the number of suspension lines.

The component of the suspension-line force in a direction parallel to the parachute center line is simply

$$(F_{SL_V})_{FR} = \frac{F_O}{N} , \quad (4\text{-}11)$$

and the component normal to the center line is

$$(F_{SL_H})_{FR} = \frac{F_O}{N} \tan \alpha_{FR}. \quad (4\text{-}12)$$



PARACHUTE FORCES

Fig. 12. Assumed force behavior of full reef for the reefing line of a parachute employing the vent-pulldown technique.

For the parachute to be in reefed equilibrium,

$$(F_{R_V})_S = (F_{SL_V})_{FR}. \tag{4-13}$$

The force in the main seam radially directed from the skirt is

$$(F_R)_S = \frac{F_O}{N \cos \beta_{FR}} . \tag{4-14}$$

It can be shown that

$$(F_{R_H})_S = \frac{F_O}{N} \tan \beta_{FR}. \tag{4-15}$$

The force that normally tends to open the mouth of the parachute is $(F_{S_N})_{FR}$, and can be expressed as

$$(F_{S_N})_{FR} = (F_{R_H})_S - (F_{SL_H})_{FO}. \tag{4-16}$$

Substituting Eqs. (4-12) and (4-15) into Eq. (4-16) yields

$$(F_{S_N})_{FR} = \frac{F_O}{N} (\tan \beta - \tan \alpha)_{FR}. \tag{4-17}$$

If it is desired to use reefing, it can be seen that the force acting directly on the reefing rings (as a result of the reefing line's resistance to the opening tendencies) has a magnitude equal to $(F_{S_N})_{FR}$ but opposite in direction.

The force in the reefing line can now be simply expressed as

$$F_{RL} = \frac{(F_{S_N})_{FR}}{2 \sin (360/2N)} . \tag{4-18}$$

Substituting Eq. (4-17) into Eq. (4-18) yields

$$\frac{F_{RL}}{F_O} = \frac{(\tan \beta - \tan \alpha)_{FR}}{2N \sin (360/2N)} . \tag{4-19}$$

However, it becomes desirable to express the forces in the reefing line in terms of the reefing ratio. From Fig. 12, it can be seen that

$$\alpha = \sin^{-1} \frac{\frac{1}{2}D_R}{L_{SL}} . \qquad (4\text{-}20)$$

The reefing ratio is defined by

$$R_{FR} = \frac{D_{FR}}{D_O} , \qquad (4\text{-}21)$$

where D_R is the steady-state diameter, and D_O is the diameter of the flattened canopy. Now, substituting the latest two equations into Eq. (4-19) finally leads to

$$\frac{F_{RL}}{F_O} = \frac{\tan \beta_{FR} - \tan [\sin^{-1} (RD_O/2L_{SL})]_{FR}}{2N \sin (360/2N)} . \qquad (4\text{-}22)$$

(2) Selected Prototype Parachute Assembly

Figure 13 depicts the curves plotting Eq. (4-22) for various β-values. These curves are based upon the geometry associated with the selected prototype parachute assembly; that is,

$$D_O = 135 \text{ ft},$$

$$L_{SL} = 169 \text{ ft},$$

and

$$N = 160 \text{ gores}.$$

Referring to Fig. 10, it can be seen that $\beta_{FR} = 18°$. In addition, the established reefing ratio, R_{FR}, for the selected prototype is approximately 19.1% (Volume I, Section 10.2, p. 161). Hence, from Fig. 13,

$$\frac{F_{RL}}{F_O} = 0.042 . \qquad (4\text{-}23)$$

Since, for this case, F_C is 28,300 lb, then

$$F_{RL} = 1187 \text{ lb}. \qquad (4\text{-}23a)$$

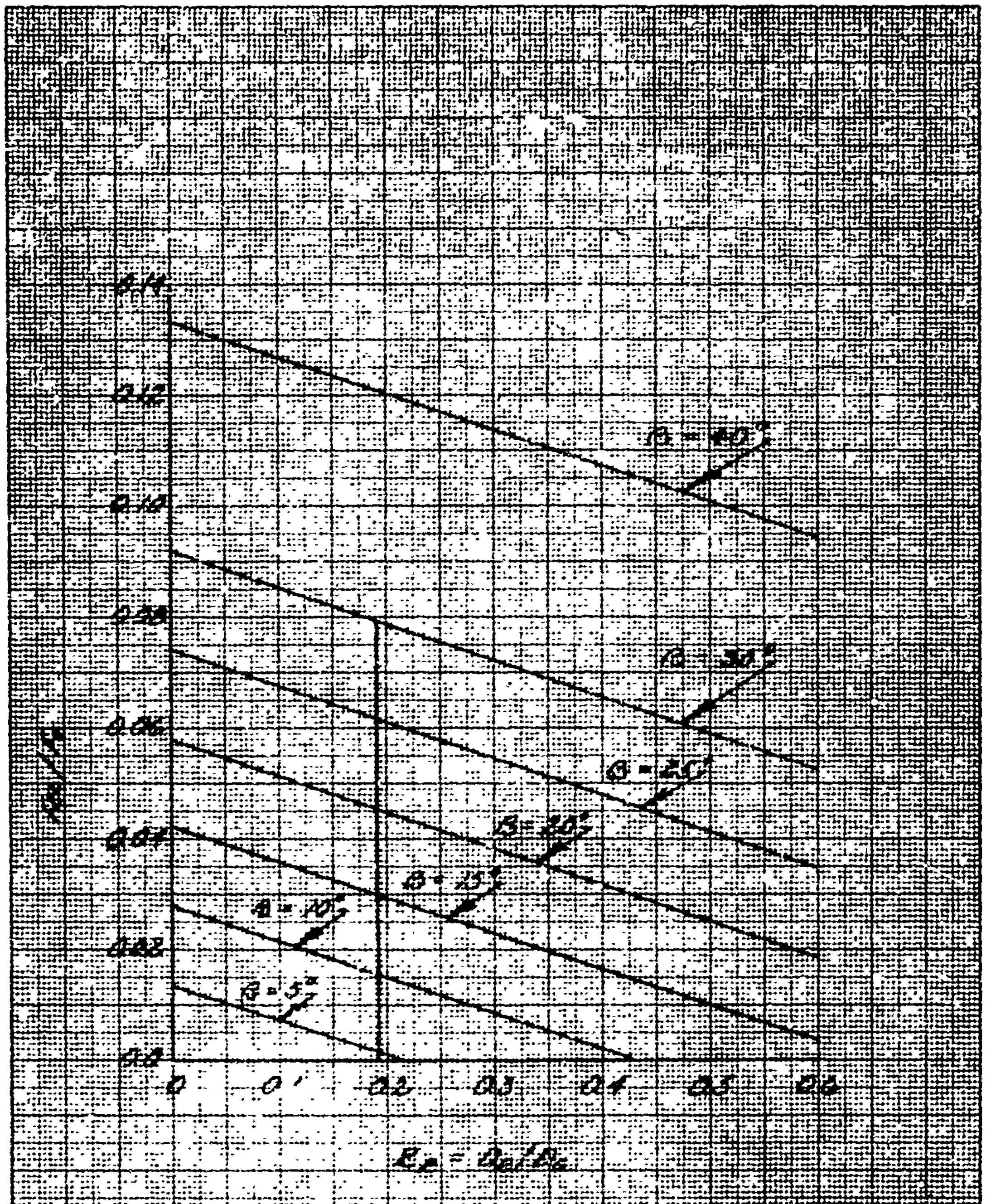


FIGURE 13 - RATIO OF REEFING-LINE FORCE TO OPENING FORCE VS REEFING RATIO FOR 135 FT PARACHUTE

Now it is possible to arrive at the allowable load on the reefing line. From Eq. (4-1),

$$\text{allow load} = \frac{2749\ \text{lb}}{2.18} = 1261\ \text{lb.} \tag{4-1d}$$

From Eq. (4-2), the margin of safety is calculated to be

$$\text{M.S.} = \frac{1261\ \text{lb}}{1187\ \text{lb}} - 1 = +0.06. \tag{4-2d}$$

c. Skirt-reinforcing Band

It can be reasonably assumed that the skirt-reinforcing band experiences its maximum force at approximately full open since, in this condition, the scalloped shape associated with the skirt is minimized. Reference to Volume I, p. 164, reveals that it is also reasonable to assume that the maximum parachute force is approximately the same for full open as for full reef.

(1) Load Experienced by the Skirt-reinforcing Band

Figure 14 depicts the assumed force behavior at full open for the skirt of a parachute employing the vent-pulldown technique. Using rationale similar to that exemplified in calculating the reefing-line force enables the calculation of the maximum load experienced by the skirt-reinforcing band. To do this, the very conservative assumption is made that there is no scalloping effect at the skirt.

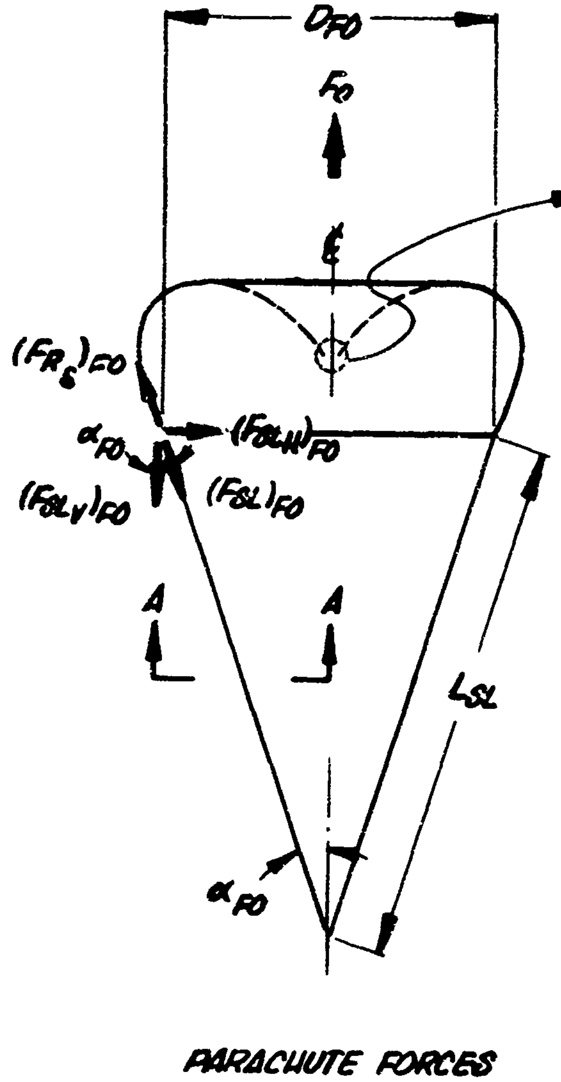
A portion of the aerodynamic force acting on the gore is resisted at the skirt. This resistance is equal to the horizontal component of the suspension-line force,

$$(F_{SL_H})_{FO} = \frac{(F_{SL_V})_{FO}}{N} \tan \alpha_{FO}. \tag{4-24}$$

View A-A of Fig. 14 shows that the force in the skirt-reinforcing band at full open becomes

$$(F_{SB})_{FO} = \frac{(F_{SL_H})_{FO}}{2 \sin (360/2N)} . \tag{4-25}$$

Substituting Eq. (4-24) into Eq. (4-25) yields



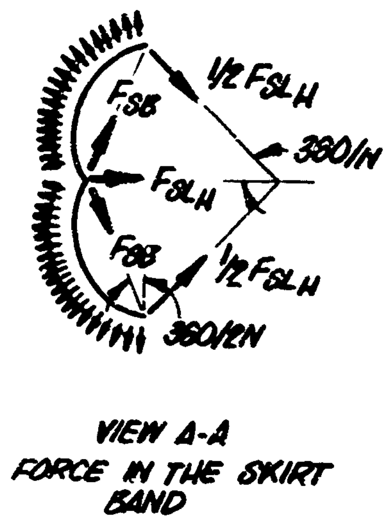


Fig. 14. Assumed force behavior at full open for the skirt of a parachute employing the vent-pulldown technique.

$$(F_{SB})_{FO} = \frac{(F_{SL_V})_{FO} \tan \alpha_{FO}}{2 \sin (360/2N)} . \qquad (4\text{-}26)$$

(2) Selected Prototype Parachute Assembly

The geometry associated with the prototype parachute assembly, shown at full open in Fig. 14, is as follows.

$D_{FO} = 96$ ft,

$L_{SL} = 169$ ft,

and

$N = 160$ gores.

From this information, it can be seen that

$$\alpha_{FO} = \sin^{-1} \frac{48 \text{ ft}}{169 \text{ ft}} \qquad (4\text{-}27)$$

or

$$\alpha_{FO} = 16.5° . \qquad (4\text{-}28)$$

Use of Eq. (4-26), if the maximum force at full open is 28,300 lb, yields

$$(F_{SB})_{FO} = \frac{28,300 \tan 16.5°}{2 \times 160 \times \sin (360/2N)} = 1375 \text{ lb}. \qquad (4\text{-}26a)$$

The allowable load on the skirt-reinforcing band is calculated by Eq. (4-1). Hence,

$$\text{allow load} = \frac{4598 \text{ lb}}{2.34} = 1960 \text{ lb}. \qquad (4\text{-}1e)$$

From Eq. (4-2), the margin of safety is calculated to be

$$\text{M.S.} = \frac{1960 \text{ lb}}{1375 \text{ lb}} - 1 = +0.43. \qquad (4\text{-}2e)$$

d. Vent-reinforcing Band

It can be reasonably assumed that the vent-reinforcing band experiences its maximum force at approximately full open, since in this condition the scalloped shape associated with the vent is minimized.

(1) Load Experienced by the Vent-reinforcing Band

Referring to Fig. 14, it can be assumed that at full open the force in the radial main seam at the skirt is equal to the force in the suspension line. Hence,

$$(F_{R_S})_{FO} = (F_{SL})_{FO}. \tag{4-29}$$

Carrying this reasoning further, one can state that the force or tension in that portion of the suspension line that traverses the main seam is constant throughout. Therefore, it can be assumed that, at full open, force in the main radial seam at the skirt is equal to the force in the main radial seam at the vent:

$$(F_{R_S})_{FO} = (F_{R_{vt}})_{FO}. \tag{4-30}$$

Substituting Eq. (4-29) into Eq. (4-30) yields

$$(F_{R_{vt}})_{FO} = (F_{SL})_{FO}. \tag{4-31}$$

The algebraic summation of the horizontal components of $(F_{R_{vt}})_{FO}$ and the vent-line force $(F_{VL})_{FO}$ yields the value of the normal force pulling outward on the vent-reinforcing band, creating its tension load:

$$(F_{vt_N})_{FO} = (F_{R_{vt_H}})_{FO} - (F_{VL_H})_{FO}. \tag{4-32}$$

From reasoning similar to that used for the reefing line, the tension or force in the vent-reinforcing band at full open can now be conservatively stated as

$$(F_{VB})_{FO} = \frac{(F_{vt_N})_{FO}}{2 \sin (360/2N)} \tag{4-33}$$

Substituting Eq. (4-32) into Eq. (4-33) yields

$$(F_{VB})_{FO} = \frac{(F_{R_{vt_H}})_{FO} - (F_{VL_H})_{FO}}{2 \sin (360/2N)} \tag{4-33a}$$

From Fig. 15, it can be seen that

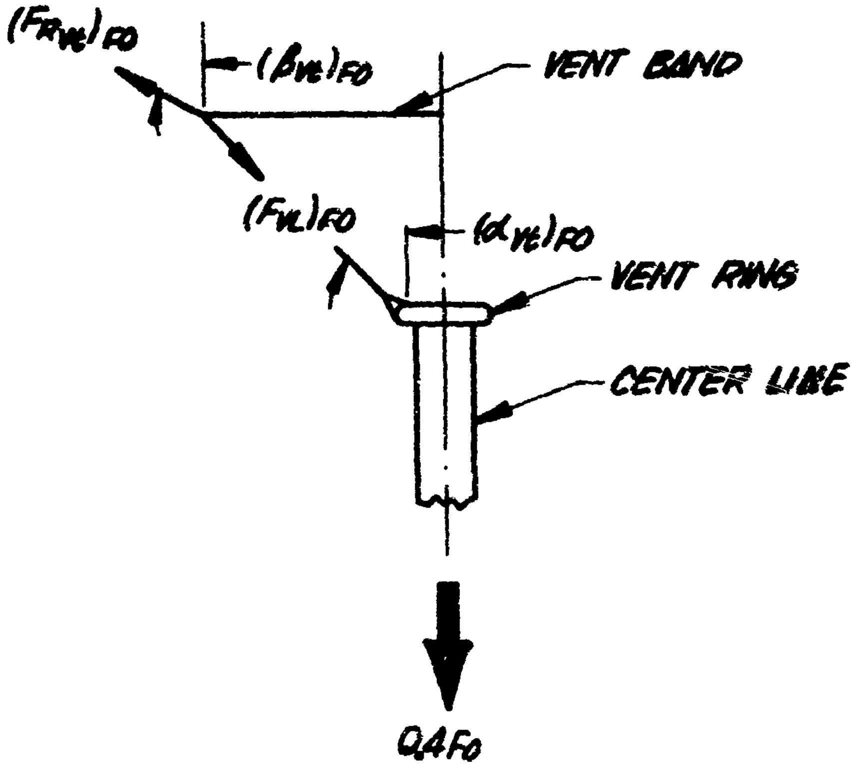


Fig. 15. Assumed force behavior at full open for the vent of a parachute employing the vent-pulldown technique.

$$(F_{R_{vt_H}})_{FO} = (F_{R_{vt_V}})_{FO} \tan (\beta_{vt})_{FO} \qquad (4\text{-}34)$$

and

$$(F_{VL_H})_{FO} = (F_{VL_V})_{FO} \tan (\alpha_{vt})_{FO}. \qquad (4\text{-}35)$$

Substitution of Eqs. (4-34) and (4-35) into Eq. (4-33a) yields

$$(F_{VB})_{FO} = \frac{(F_{R_{vt_V}})_{FO} \tan (\beta_{vt})_{FO} - (F_{VL_V})_{FO} \tan (\alpha_{vt})_{FO}}{2 \sin (360/2N)}. \qquad (4\text{-}33b)$$

To satisfy equilibrium conditions,

$$(F_{R_{vt_V}})_{FO} = (F_{VL_V})_{FO}, \qquad (4\text{-}36)$$

and Eq. (4-33b) becomes

$$(F_{VB})_{FO} = \frac{(F_{VL_V})_{FO} [\tan (\beta_{vt})_{FO} - \tan (\alpha_{vt})_{FO}]}{2 \sin (360/2N)}. \qquad (4\text{-}33c)$$

The vertical component of the vent-line force at full open can be expressed as

$$(F_{VL_V})_{FO} = \frac{0.4\ F_O}{N}, \qquad (4\text{-}37)$$

and the angle $(\beta_{vt})_{FO}$ at full open as

$$(\beta_{vt})_{FO} = \cos^{-1} \frac{(F_{R_{vt_V}})_{FO}}{(F_{R_{vt}})_{FO}}. \qquad (4\text{-}38)$$

Substitution of Eqs. (4-31) and (4-36) into Eq. (4-38) yields

$$(\beta_{vt})_{FO} = \cos^{-1} \frac{(F_{VL_V})_{FO}}{(F_{SL})_{FO}}. \qquad (4\text{-}38a)$$

From Fig. 14, it can be seen that

$$(F_{SL_V})_{FO} = \frac{(F_{SL})_{FO}}{\cos\alpha_{FO}} . \qquad (4\text{-}39)$$

Since

$$(F_{SL_V})_{FO} = \frac{F_O}{N} , \qquad (4\text{-}40)$$

the expression for $(\beta_{vt})_{FO}$ is reduced to

$$(\beta_{vt})_{FO} = \cos^{-1}\left[\frac{N(F_{VL_V})_{FO}}{F_O}\cos\alpha_{FO}\right] . \qquad (4\text{-}38b)$$

Substituting Eqs. (4-37) and (4-38b) into Eq. (4-33') finally yields the force in the vent band at full open:

$$(F_{VB})_{FO} = \frac{F_O\ \{\tan[\cos^{-1}(0.4N\cos\alpha_{FO})] - \tan(\alpha_{vt})_{FO}\}}{5N\sin(360/2N)} . \qquad (4\text{-}33d)$$

In the prototype parachute assembly under study, the following information is characteristic at full open:

$F_O = 28{,}300$ lb,

$N = 160$ gores

$\alpha_{FO} = 16.5°$,

and

$(\alpha_{vt})_{FO} = 45°$.

Substitution of these values into Eq. (4-33d) yields

$$(F_{VB})_{FO} = 1060 \text{ lb}. \qquad (4\text{-}41)$$

The allowable load on the vent-reinforcing band is calculated by Eq. (4-1). This leads to

$$\text{allow load} = \frac{4598 \text{ lb}}{2.48} = 1850 \text{ lb}. \qquad (4\text{-}1f)$$

Use of Eq. (4-2) leads to the following margin of safety.

$$M.S. = \frac{1850 \text{ lb}}{1060 \text{ lb}} - 1 = +0.75. \qquad (4\text{-}2f)$$

e. Suspension Lines

The ultimate load of the suspension lines is calculated from the expression

$$\text{ult load} = (\text{no. of lines}) \times (\text{line strength}). \qquad (4\text{-}42)$$

For the case herein,

$$\text{no. of lines} = 160$$

and

$$\text{line strength} = 591 \text{ lb};$$

hence,

$$\text{ult strength} = (160 \text{ lines}) \times (591 \text{ lb/line}) = 94{,}500 \text{ lb}. \qquad (4\text{-}42a)$$

(1) Suspension Lines Joined at Connector Links

Equation (4-1) yields the allowable load on the suspension lines based upon the joint at the connector links:

$$\text{allow load} = \frac{94{,}500 \text{ lb}}{2.48} = 38{,}200 \text{ lb}. \qquad (4\text{-}1g)$$

The margin of safety, from Eq. (4-2), becomes

$$M.S. = \frac{38{,}200 \text{ lb}}{28{,}300 \text{ lb}} - 1 = +0.35. \qquad (4\text{-}2g)$$

(2) Suspension Lines Joined at Skirt

The allowable load on the suspension lines based upon the joint at the skirt is

$$\text{allow load} = \frac{94{,}500 \text{ lb}}{2.40} = 39{,}400 \text{ lb}. \qquad (4\text{-}1h)$$

Therefore the margin of safety is

$$M.\ S. = \frac{39{,}400 \text{ lb}}{28{,}300 \text{ lb}} - 1 = +0.39 \qquad (4\text{-}2h)$$

(3) Suspension Lines in the Main Seam Joined at the Skirt and Vent

The allowable load at the skirt and vent on the suspension lines in the main seam (since the suspension lines

run through the main seam on up to the apex) is

$$\text{allow load} = \frac{94{,}500 \text{ lb}}{2.30} = 41{,}150 \text{ lb}. \qquad (4\text{-}1i)$$

The margin of safety becomes

$$\text{M.S.} = \frac{41{,}150 \text{ lb}}{29{,}900 \text{ lb}} - 1 = +0.38, \qquad (4\text{-}2i)$$

where the total suspension-line worst-case load is calculated from use of a variation of Eq. (4-14):

$$\text{worst-case load} = \frac{F_O}{\cos \beta_{FR}}. \qquad (4\text{-}43)$$

For this case,

$$F_O = 28{,}300 \text{ lb},$$

and

$$\beta \approx 18°.$$

Hence,

$$\text{worst-case load} = \frac{28{,}300 \text{ lb}}{\cos 18°} = 29{,}900 \text{ lb}. \qquad (4\text{-}43a)$$

(4) Suspension Lines Joined at the Vent Ring

Equation (4-1) yields the allowable load on the vent lines (suspension lines running from the vent band to the vent ring):

$$\text{allow load} = \frac{94{,}500 \text{ lb}}{2.66} = 35{,}500 \text{ lb}. \qquad (4\text{-}1j)$$

The extreme worst-case load that could be experienced by the vent lines is 29,900 lb. Hence, the margin of safety for this condition becomes

$$\text{M.S.} = \frac{35{,}500 \text{ lb}}{29{,}900 \text{ lb}} - 1 = +0.19. \qquad (4\text{-}2j)$$

f. Riser

(1) Riser Joint at the Connector Link

Equation (4-1) yields the allowable load for the riser at the connector link:

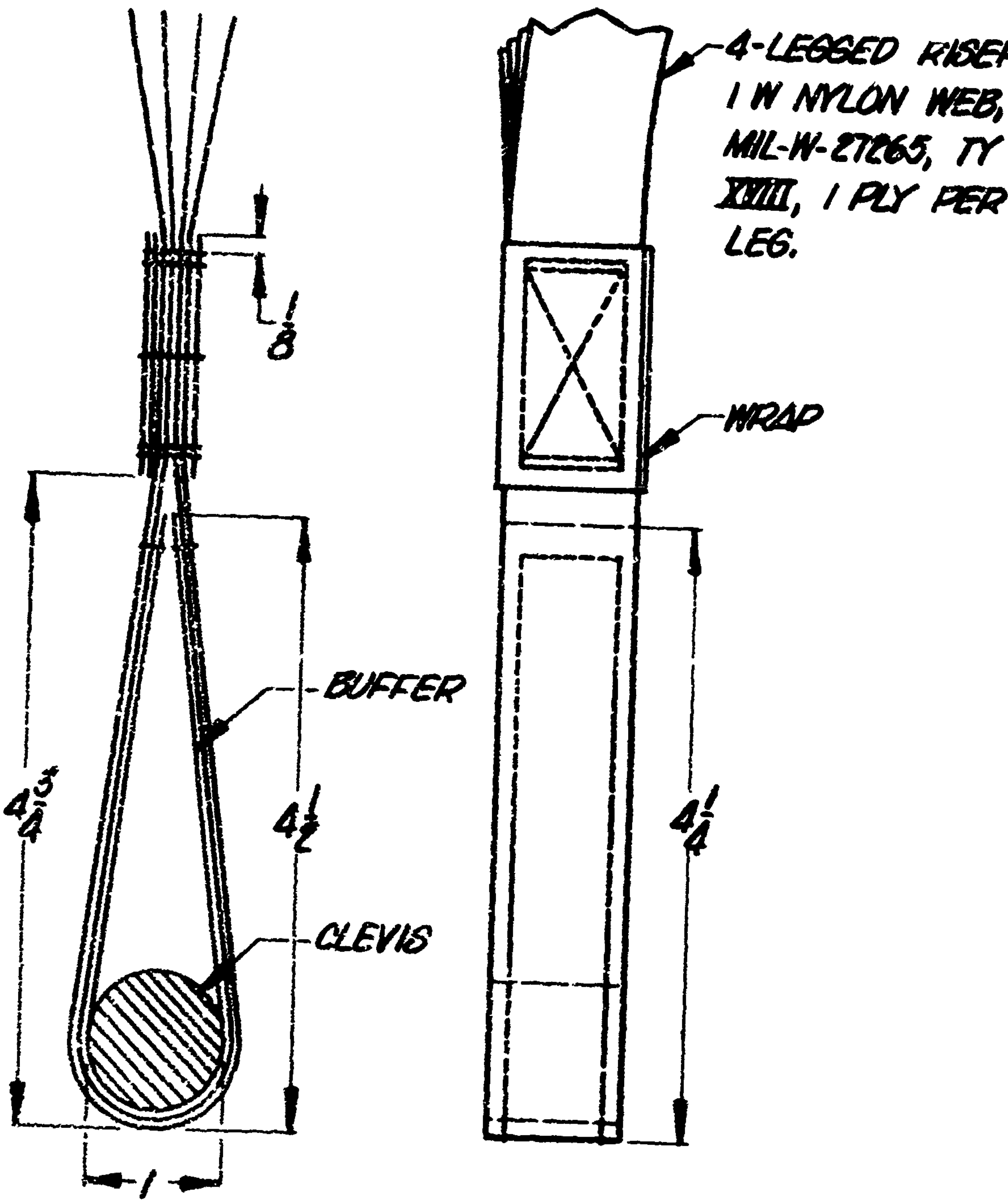


Fig. 16. Riser joint at clevis (refer to Natick Laboratories' Dwg. X11-1-1651).

$$\text{allow load} = \frac{7253 \text{ lb}}{3.06} = 2475 \text{ lb.} \qquad (4\text{-}1k)$$

The margin of safety is

$$\text{M.S.} = \frac{2475}{1870 \text{ lb}} - 1 = +0.27, \qquad (4\text{-}2k)$$

where the worst-case load experienced by the riser is based on the total worst-case load experienced by the suspension lines. The latter case is stated in Eq. (4-43a). Since ten suspension lines feed into each riser via the connector link, the riser worst-case load becomes

$$\text{worst-case load} = \frac{29,900 \text{ lb}}{160 \text{ lines}} \times (10 \text{ lines/riser})$$

$$= 1870 \text{ lb/riser.} \qquad (4\text{-}44)$$

(2) Riser Joint at the Clevis

The allowable load for the riser at the clevis is

$$\text{allow load} = \frac{(7253 \text{ lb}) \times (4 \text{ ply})}{2.62} = 11,100 \text{ lb.} \qquad (4\text{-}1m)$$

The margin of safety becomes simply

$$\text{M.S.} = \frac{11,100 \text{ lb}}{(1870 \text{ lb}) \times (4 \text{ ply})} - 1 = +0.48 \qquad (4\text{-}2m)$$

g. Center Line

(1) Center-line Joint at the Vent Ring

Equation (4-1) yields the allowable load for the center-line at the vent ring:

$$\text{allow load} = \frac{(15,512 \text{ lb}) \times (2 \text{ ply})}{2.77} = 11,200 \text{ lb.} \qquad (4\text{-}1p)$$

From Eq. (4-2), the margin of safety is

$$\text{M.S.} = \frac{11,200 \text{ lb}}{11,300 \text{ lb}} - 1 \approx 0, \qquad (4\text{-}2p)$$

where from Volume 1, p. 176, it can be seen that the center-line worst-case load is given by

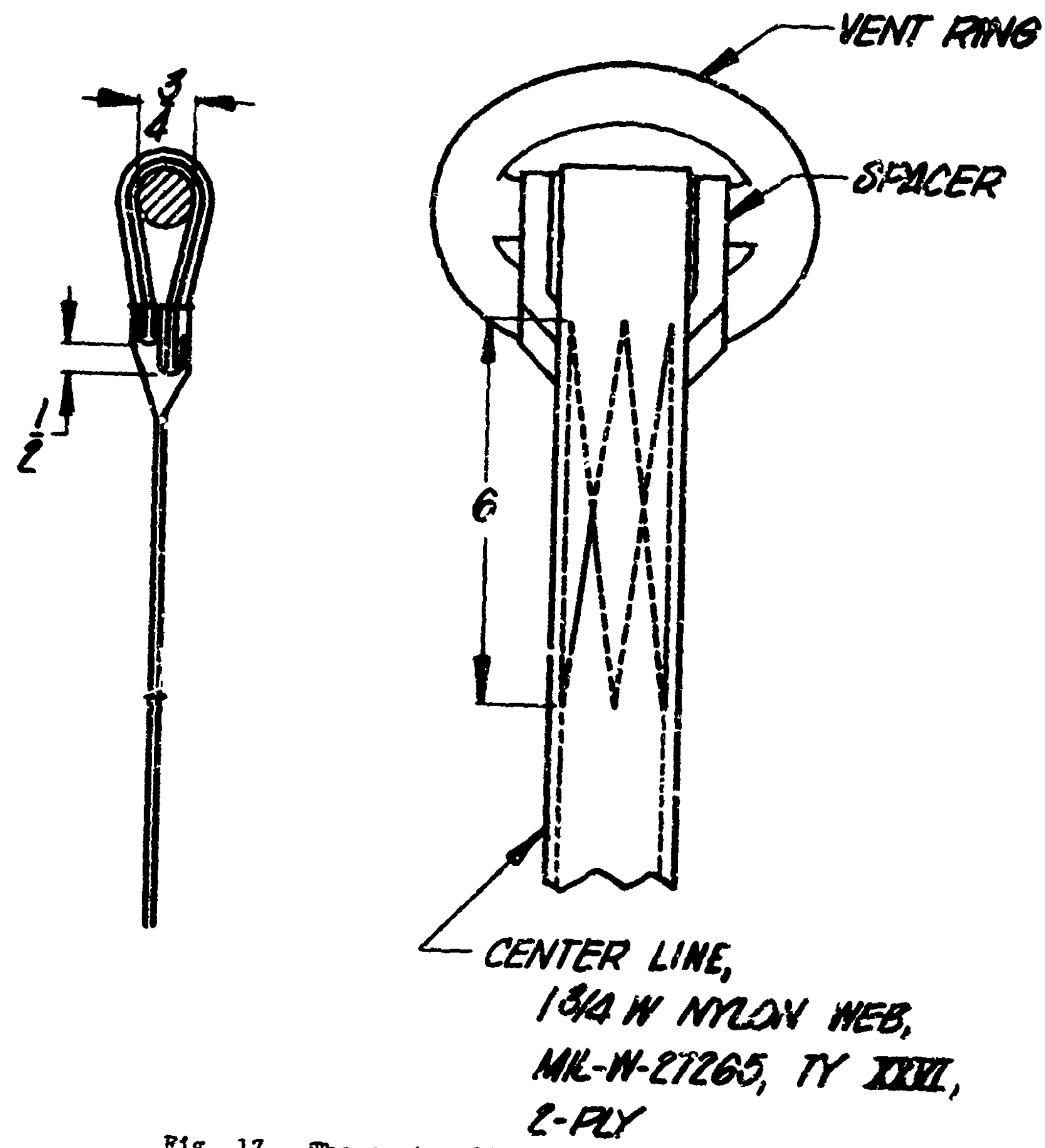


Fig. 17. The center-line joint at the vent ring.

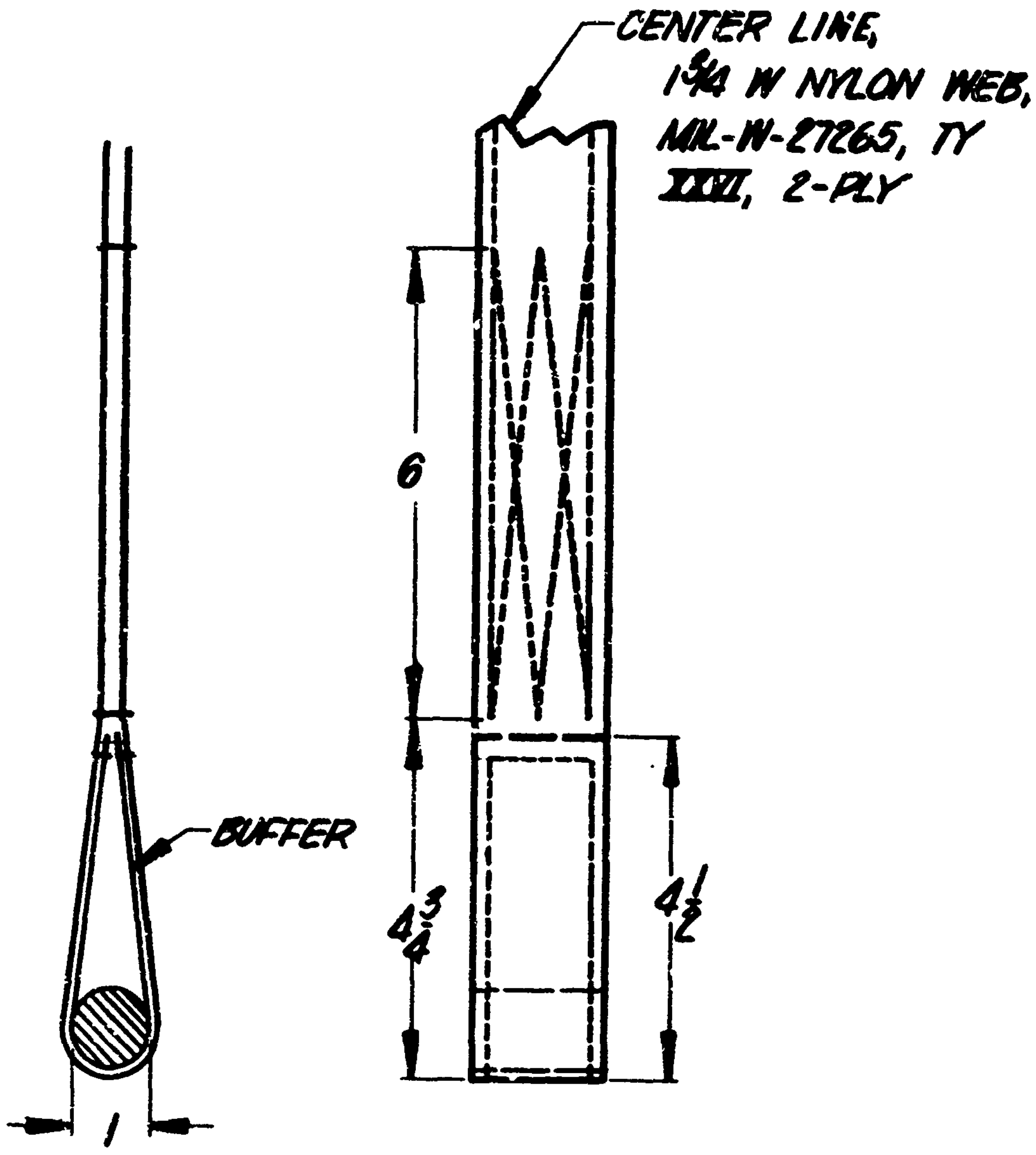


Fig. 18. Center-line joint at clevis.

$$\text{worst-case load} = 0.4 \times (28{,}300 \text{ lb}) = 11{,}300 \text{ lb.} \qquad (4\text{-}47)$$

(2) Center-line Joint at the Clevis

The allowable load on the center line at the clevis is

$$\text{allow load} = \frac{(15{,}512 \text{ lb}) \times (2 \text{ ply})}{2.64} = 11{,}750 \text{ lb.} \qquad (4\text{-}1q)$$

The margin of safety is

$$\text{M.S.} = \frac{11{,}750 \text{ lb}}{11{,}300 \text{ lb}} - 1 = +0.\ 4. \qquad (4\text{-}2q)$$

(3) Center-line Splice

(1 Margin of Safety on the Basis of Theory

Figure 19 reveals that the length of stitching for the splice is 11-5/8 in. If there are approximately 7 stitches sewn per inch, then for 8 rows of stitching there is a total of

$$(11\text{-}5/8 \text{ in./row}) \times (7 \text{ stitches/in.}) \times (8 \text{ rows})$$

$$= 650 \text{ stitches.}$$

The rated ultimate tensile strength of the thread is 50 lb. This means that, for 650 stitches, the following ultimate tensile load can be developed:

$$(650 \text{ stitches}) \times (50 \text{ lb/stitch}) = 32{,}550 \text{ lb;}$$

however, the efficiency of the thread is approximately 75%, and the abrasion and fatigue factors are 0.96 and 0.95, respectively. Noting that the safety factor is 2.0, then the thread's overall design factor becomes

$$\frac{2.0}{0.75 \times 0.96 \times 0.95} = 2.92.$$

Now, using Eq. (4-1), it becomes possible to arrive at the theoretical allowable load for the splice:

$$\text{allow load} = \frac{32{,}550 \text{ lb}}{2.92} = 11{,}120 \text{ lb.} \qquad (4\text{-}45)$$

The margin of safety for the splice becomes

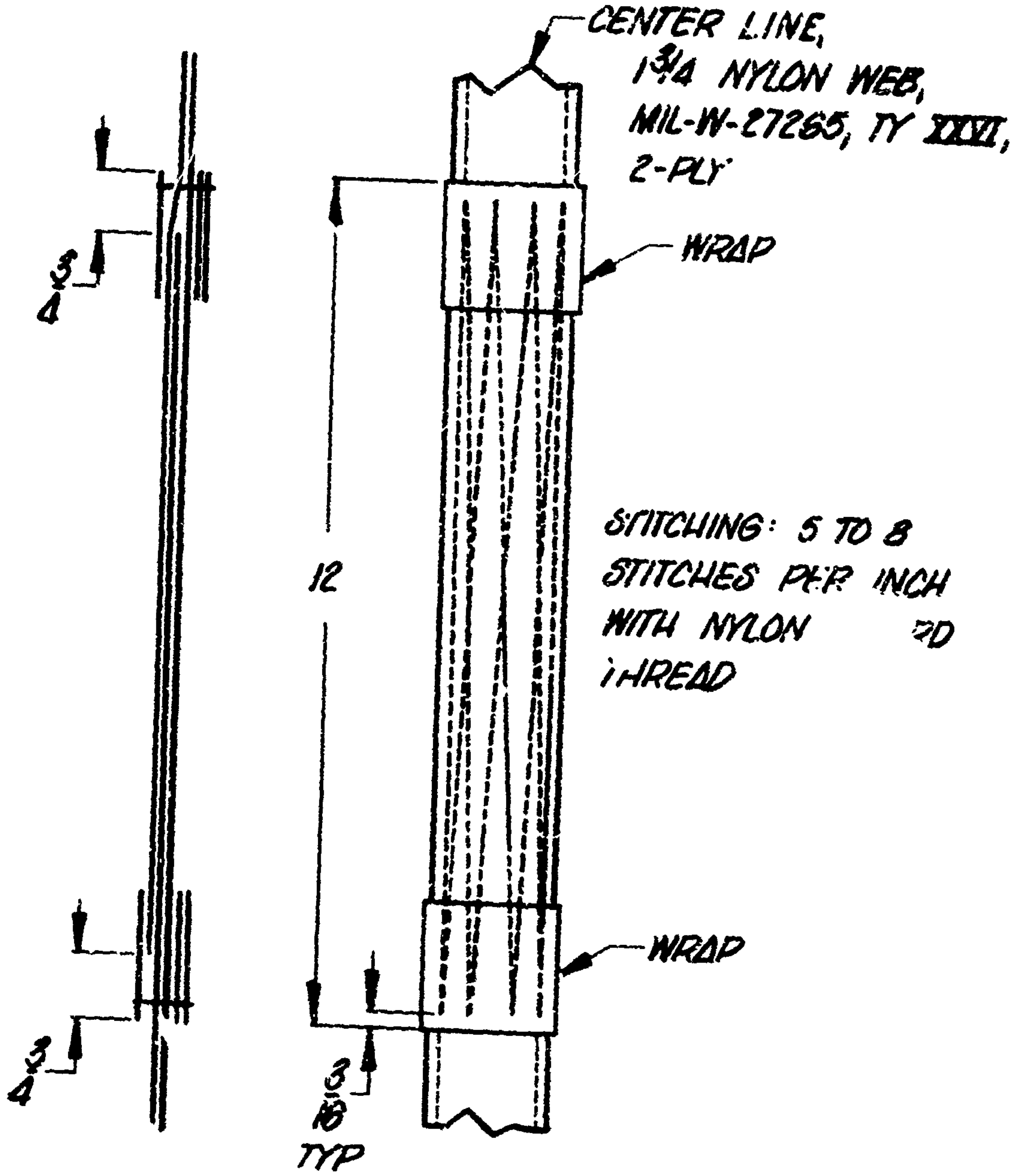


Fig. 19. Splice for the center line and main riser. (Wrap for center line is 1-3/4 W nylon web, Ty XII, for main riser, wrap is 1-3/4 W nylon web, Ty XIII; both MIL-W-27265.)

$$M.S. = \frac{11,120\ lb}{11,300\ lb} - 1 = -0.02. \quad (4\text{-}46)$$

The negative margin of safety based on theoretical determination of the efficiency of the center-line splice indicates that the center-line splice may be marginal. Hence, it becomes necessary to conduct structural tests to determine the actual efficiency of the splice.

(2 Margin of Safety on the Basis of Tests

Appendix A shows that testing reveals the allowable load for the center-line splice to be

$$\text{allow load} = \frac{(15,512\ lb) \times (2\ ply)}{2.68} = 11,600\ lb. \quad (4\text{-}1r)$$

The margin of safety, therefore, becomes

$$M.S. = \frac{11,600\ lb}{11,300\ lb} - 1 = +0.03. \quad (4\text{-}2r)$$

This margin of safety is higher than that arrived at from theory (Eq. 4-46); hence, it can be concluded from the results of Eqs. (4-46) and (4-2r) that the margin of safety derived from theory is reasonably conservative.

h. Riser Extension

The riser extension (or main riser) is of 6-ply webbing. Because of the high anticipated ultimate strength of the riser extension (of the order of 90,000 lb) destruct testing at Pioneer's laboratory facilities becomes infeasible. As a result, the means for arriving at this configuration's joint efficiency is accomplished by theoretical calculations based on those presented in ref. 4 and summarized by the curve depicted in Fig. 21.

Table 6 presents the results of the above theory. It shows that the correlation between the theoretical joint efficiencies and the test joint efficiencies for both the riser and center line compare favorably. In fact, the theory is somewhat conservative. As a result, it can be stated with confidence that the riser-extension joint efficiencies arrived at through the theory presented in ref. 4 are reasonably realistic.

In Fig. 21, the curve defines the joint efficiency of a webbing around a pin. The parameter is given by the expression r_1/Nt, where N is the number of webbing plies, r_1

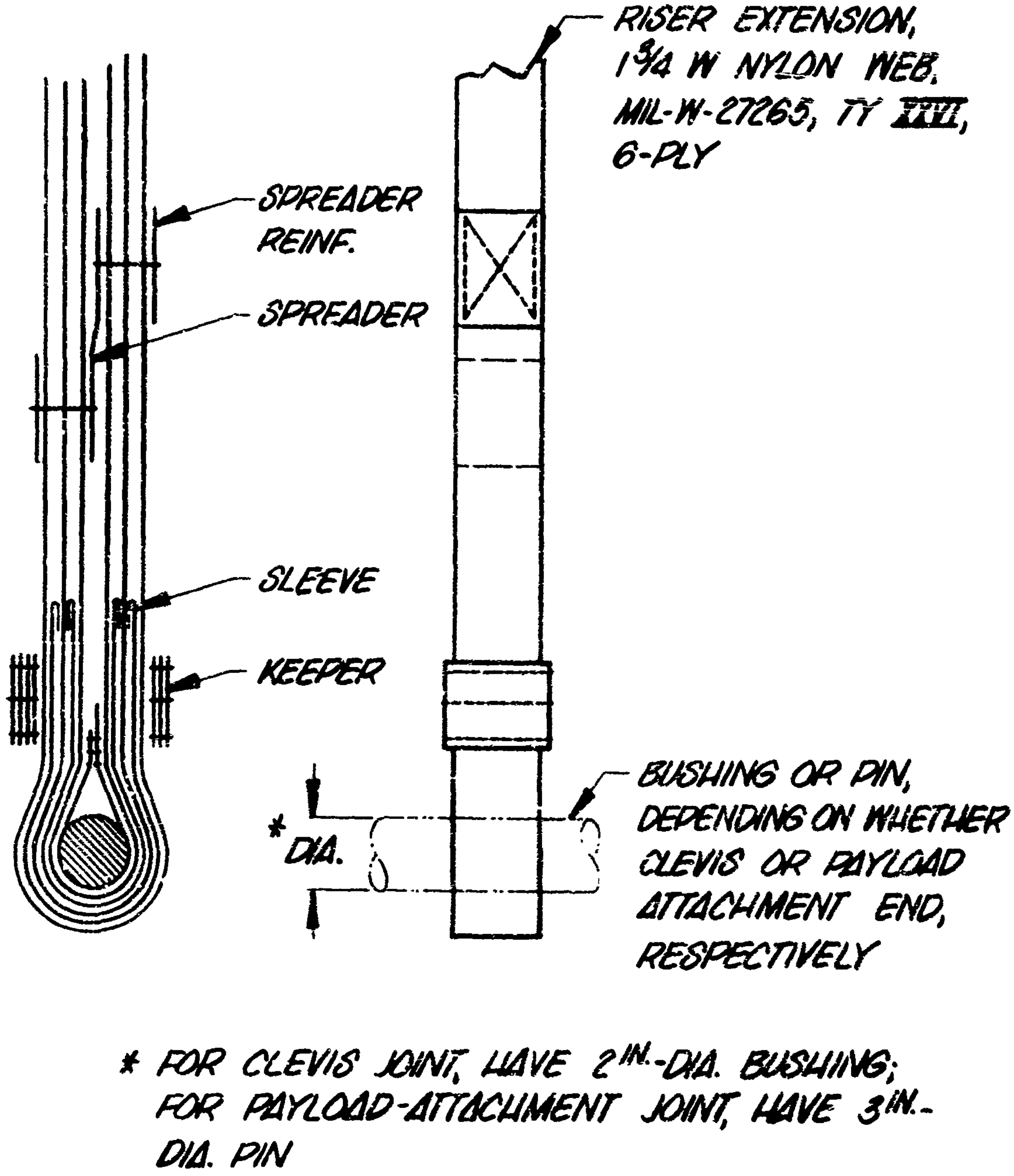


Fig. 20. Riser-extension joints at clevis and payload-attachment ends.

TABLE 6
COMPARISON OF EFFICIENCIES BASED
ON THEORY AND TEST

Item	r_1, in.	N	t, in.	r_1/Nt	n, in.	Test eff., %
Riser						
Conn. link	0.164	1	0.094	1.75	75	75
Clevis	0.50	2	0.094	2.66	85	88
Center line						
Vent ring	0.37	1	0.156	2.40	83.5	83.4
Clevis	1.0	1	0.156	6.40	94*	94
Riser extension						
Clevis bushing	1.00	3	0.156	2.14	82	-
Payload attachment	1.50	3	0.156	3.21	87	-

*Although the actual clevis radius is 0.50 in., the structual test of the attachment of the center line to the clevis was conducted with a pin of 1.00-in. radius (r_1 = 1.00).

As shown, the comparison between the efficiency predicted by theory (n) and that arrived at by test is excellent. Hence, the efficiency of the attachment of the center line to the clevis by a pin of 0.50-in. radius can be realistically established as 87%, based on the curve depicted in Fig. 11.

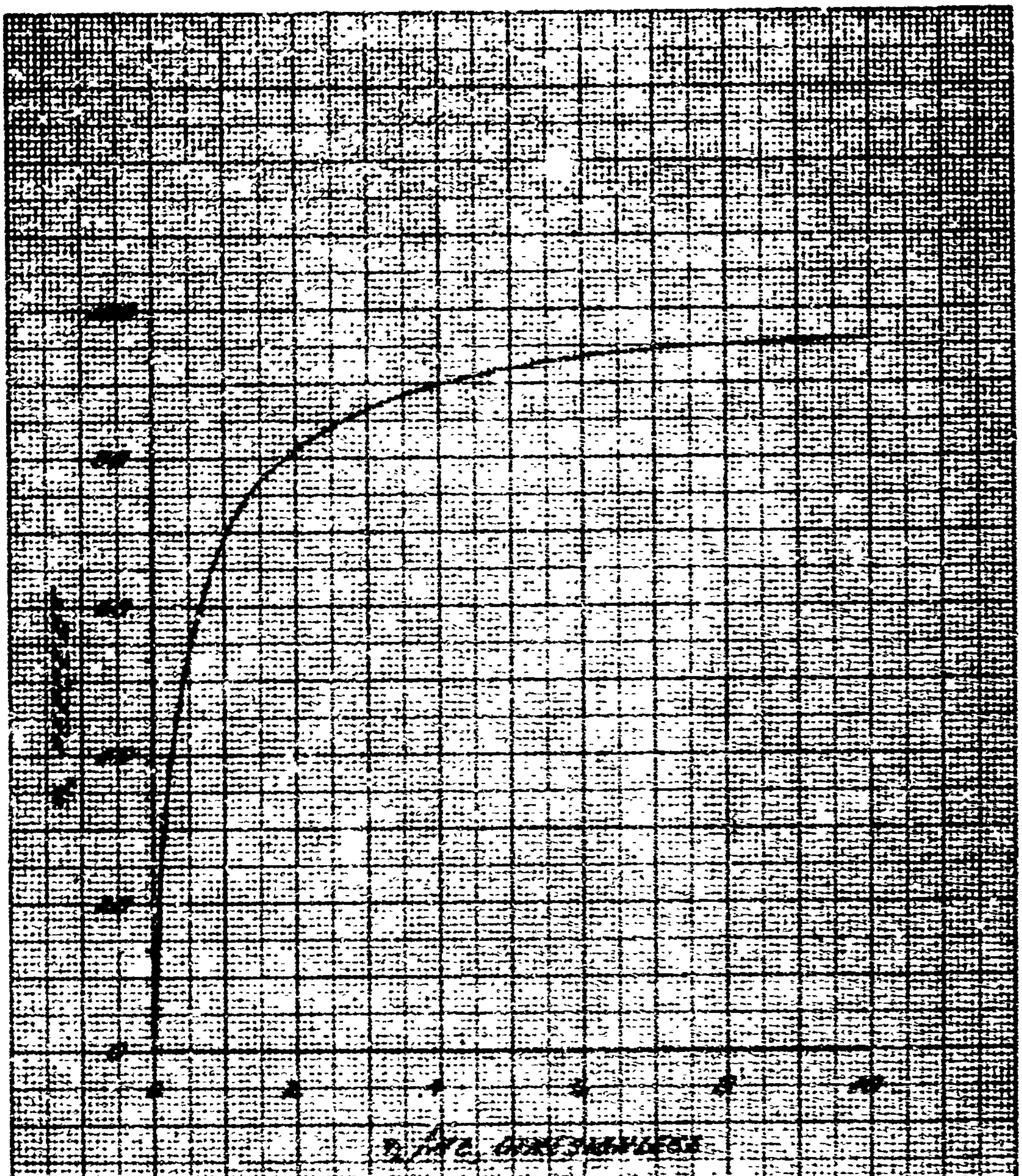


FIGURE R.1 — THEORETICAL EFFICIENCIES VERSUS

is the inside radius of the innermost ply of webbing (in inches), and t is the webbing's thickness (in inches). The curve fails to account for the reinforcing effect of any buffer or sleeves; hence, r_1 becomes simply the radius of the pin.

(1) Riser-extension Joint at the Clevis

Equation (4-1) yields the allowable load for the riser extension:

$$\text{allow load} = \frac{(15{,}512 \text{ lb}) \times (6 \text{ ply})}{2.82} = 33{,}000 \text{ lb.} \quad (4\text{-}1s)$$

The margin of safety, from use of Eq. (4-2), is calculated to be

$$\text{M.S.} = \frac{33{,}000 \text{ lb}}{28{,}300 \text{ lb}} - 1 = +0.17. \quad (4\text{-}2s)$$

(2) Riser-extension Joint at the Payload Attachment

The allowable load for the riser extension at the payload attachment is

$$\text{allow load} = \frac{(15{,}512 \text{ lb}) \times (6 \text{ ply})}{2.68} = 37{,}800 \text{ lb.} \quad (4\text{-}1t)$$

The margin of safety is

$$\text{M.S.} = \frac{34{,}800 \text{ lb}}{28{,}300 \text{ lb}} - 1 = +0.23. \quad (4\text{-}2t)$$

(3) Riser-extension Splice

(1) Margin of Safety on the Basis of Theory

Since the riser-extension splice is the same as that for the center line with the exception of the wrap, and since the theoretical calculations ignore the influence of the wrap, the margin of safety for the riser-extension splice is the same as that for the center line; therefore, reference is made to Section 4.g(3)(1 of this volume.

(2) Margin of Safety on the Basis of Tests

Appendix A shows that testing reveals the allowable load for the riser-extension splice to be

$$\text{allow load} = \frac{(1[illegible] \text{ lb}) \times (2 \text{ ply})}{[illegible]} = 11{,}850 \text{ lb.} \quad (4\text{-}1u)$$

TABLE 7
MATERIAL AND WEIGHTS

Item	Material	Qty, yd	Wt, lb
1.0 Canopy assembly			
1.1 Canopy cloth	36-in. nylon, 1.6 oz/yd², O.G., MIL-C-7020, Ty II	2025	202.5
1.2 Skirt and vent reinf.	1 W nylon web, color opt., MIL-W-5625	200	16.3
1.3 Rip tapes	1/2 W nylon tape, O.D., MIL-T-5038, Ty III	60	0.6
1.4 Susp. lines, pocket bands, reefing-ring retainers	Nylon cord, O.D., MIL-C-5040, Ty III	6800	90.7
1.5 Susp.-line reinf.	9/16 W nylon web, O.D., MIL-W-4088, Ty I	25	0.4
1.6 Cutter patch	Nylon cloth, 7.25 oz/yd², O.D., MIL-C-7219, Ty III	1	0.5
1.7 Reefing line	Nylon cord, color opt., MIL-C-7515, Ty VII	30	2.0
1.8 Reefing-line wrap	3/4 W adhesive-back ripstop	4	
1.9 Thread	Nylon, size E, O.D., V-T-295, Ty I, Cl I; and cotton, 5-cord, O.D., MIL-T-5660	- -	2.0
SUBTOTAL			315.0
2.0 Center-line assembly			
2.1 Main web	1-3/4 nylon web, O.D., MIL-W-27265, Ty XXVI	123	38.1
2.2 Wrap	1-3/4 nylon web, O.D., MIL-W-27265, Ty XII	2/3	
2.3 Spacer	Nylon duck, sage green, MIL-C-3953, Cl 2	2/3	
2.4 Binding	3/4 W nylon tape, O.D., MIL-T-5038, Ty III	-	
2.5 Thread	Nylon, size E, O.D., V-T-295, Ty I, Cl I; and Nylon, 6-cord, O.D., V-T-295, Ty I, Cl I	-	0.9
SUBTOTAL			39.0

TABLE 7
con't

3.0 Riser assembly			
3.1 Main web	1 W nylon web, O.D., MIL-W-27265, Ty XVIII	672	104.9
3.2 Spacer	1-3/4 W nylon web, O.D., MIL-W-27265, Ty XIII	6	
3.3 Wrap	1-3/4 W nylon web, O.D., MIL-W-27265, Ty VIII	1	1.5
3.4 Buffer	1-3/4 W cotton web, O.D., MIL-W-5665, Ty XVII	1-1/2	
3.5 Thread	Nylon, 6-cord, O.D., V-T-295, Ty I, Cl I	-	
SUBTOTAL			106.4
4.0 Riser-extension assembly			
4.1 Main web	1-3/4 W nylon web, O.D., MIL-W-27265, Ty XXVI, Cl R	270	82.5
4.2 Spreader	1-3/4 W nylon web, O.D., MIL-W-27265, Ty XIII, Cl R	5	1.0
4.3 Spreader reinf.	1-3/4 W nylon web, O.D., MIL-W-27265, Ty VIII, Cl R	5	0.5
4.4 Wrap	1-3/4 W nylon web, O.D., MIL-W-27265, Ty VIII, Cl R	1	
4.5 Sliding keeper	1-3/4 W nylon web, O.D., MIL-W-27265, Ty XIII, Cl R	1	
4.6 Buffer	Cotton cloth, O.D., MIL-C-5645, Ty III	-	1.0
4.7 Thread	Nylon, 6-cord, O.D., V-T-295, Ty I, Cl 1	-	
	Nylon, size E, O.D., V-T-295, Ty I, Cl 1	-	
	Cotton, 6-cord, O.D., MIL-T-5660, Ty II, Style A	-	
SUBTOTAL			85.0
5.0 Bag-bridle assembly			
5.1 Main web	1-3/4 cotton web, O.D., MIL-W-5665, Ty X or XV, Cl 2B or 3	5	1.0
5.2 Wrap, buffer	1-3/4 cotton web, O.D., MIL-W-5665, Ty VIII, Cl 2B or 3	1-1/3	0.2
5.3 Thread	Nylon, 6-cord, O.D., V-T-295, Ty 1, Cl 1	-	
SUBTOTAL			1.2

TABLE 7
Concl.

6.0 Deployment-bag assembly	Refer X11-1-1654	1	25.0
SUBTOTAL			25.0
7.0 Hardware			
7.1 Vent ring	Refer X11-1-1649	1	0.8
7.2 Separable link	Refer MS22002-1	20	3.1
7.3 Clevis assembly	Refer MS70D87-3 and X11-1-1652	1	8.0
7.4 Cutter bracket	Refer 64D22262	4	0.5
7.5 Reefing ring	Refer 48A7995	164	1.1
SUBTOTAL			18.5
TOTAL WEIGHT			589.7
OVERAGE [(589.7 lb) × 0.13]			76.5
Total estimated weight of one prototype parachute assembly packed for service (total weight less overage)			513.2

The margin of safety is

$$M.S. = \frac{11,850 \text{ lb}}{(28,300 \text{ lb})/3} - 1 = +0.25. \qquad (4\text{-}2u)$$

Once again, it is shown that the margin of safety for the splice derived from theoretical calculations is reasonably conservative. It can also be seen that use of a stronger wrap for the riser-extension splice yields a slightly higher margin of safety than for the splice for the center line using the lesser-strength wrap.

5. MATERIAL LIST AND WEIGHTS

The materials comprising the prototype parachute assembly are listed in Table 7 along with corresponding weights. The materials list accounts for approximately a 13% overage; this overage is deducted to arrive at a reasonable estimated total weight.

6. ACKNOWLEDGMENTS

The authors wish to acknowledge the administrative assistance, and the reviews, and suggestions provided by Messrs. Arthur W. Claridge, Roman W. Maire, and Stanley Shute, all of the U. S. Army Natick Laboratories. Mr. Claridge served as the project officer.

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7. REFERENCES

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2. Toni, Royce A., Wolfgang R. Mueller, Milan M. Knor, and Marcia G. Wood, "Prototype Cluster-Parachute Recovery Systems for a 50,000-lb Unit Load" Vol. 1 - Design Study. Prepared for Airdrop Engineering Laboratory, U.S. Army Natick Laboratories, Natick, Mass., Jan. 1969.

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APPENDIX A

LABORATORY TEST REPORTS

E-0154, TL SERIES

FOREWORD

The tests reported in this Section were made to ascertain the structural integrity of the primary structural members of the 135-ft nominal diameter cargo parachute, NLABS drawing no. X11-1-1645.

TABLE A-1
LABORATORY TEST REPORTS
E-0154, TL SERIES

Test No. E-0154, TL	Item(s) tested	Page
1	Nylon cloth, control sample	64
2	Nylon cloth, bias-cut, control sample	66
3	Reefing line, control sample	68
4	Nylon cord, control sample	69
5	Nylon web, MIL-W-5625, 4,000 lb, control sample	70
6	Nylon web, 1 W, MIL-W-27265, Ty. XVIII, control sample	71
7	Nylon web, 1 3/4 W, MIL-W-27265, Ty. XXVI, control sample	72
8	Attachment, vent line to vent ring	73
8-1	Attachment, vent line to vent ring	75
9	Attachment, vent line to vent band	77
10	Hem, vent band	79
11	Joint (on the bias), main seam	81
12	Joint, cross seam	83
13	Hem, skirt band	85

(continued on next page)

TABLE A-1 (continued)
LABORATORY TEST REPORTS
E-0154, TL SERIES

Test No. E-0154, TL	Item(s) tested	Page
14	Attachment, suspension line to skirt	87
15	Attachment, suspension line to link	89
16	Attachment, reefing ring	91
17	Reefing line splice	93
17-1	Reefing line splice	95
18	Attachment, center line to vent ring	96
19	Attachment, center line to clevis	98
20	Riser extension splice	100
21	Center line splice	102
22	Attachment, riser to clevis	103
23	Attachment, riser to link	105

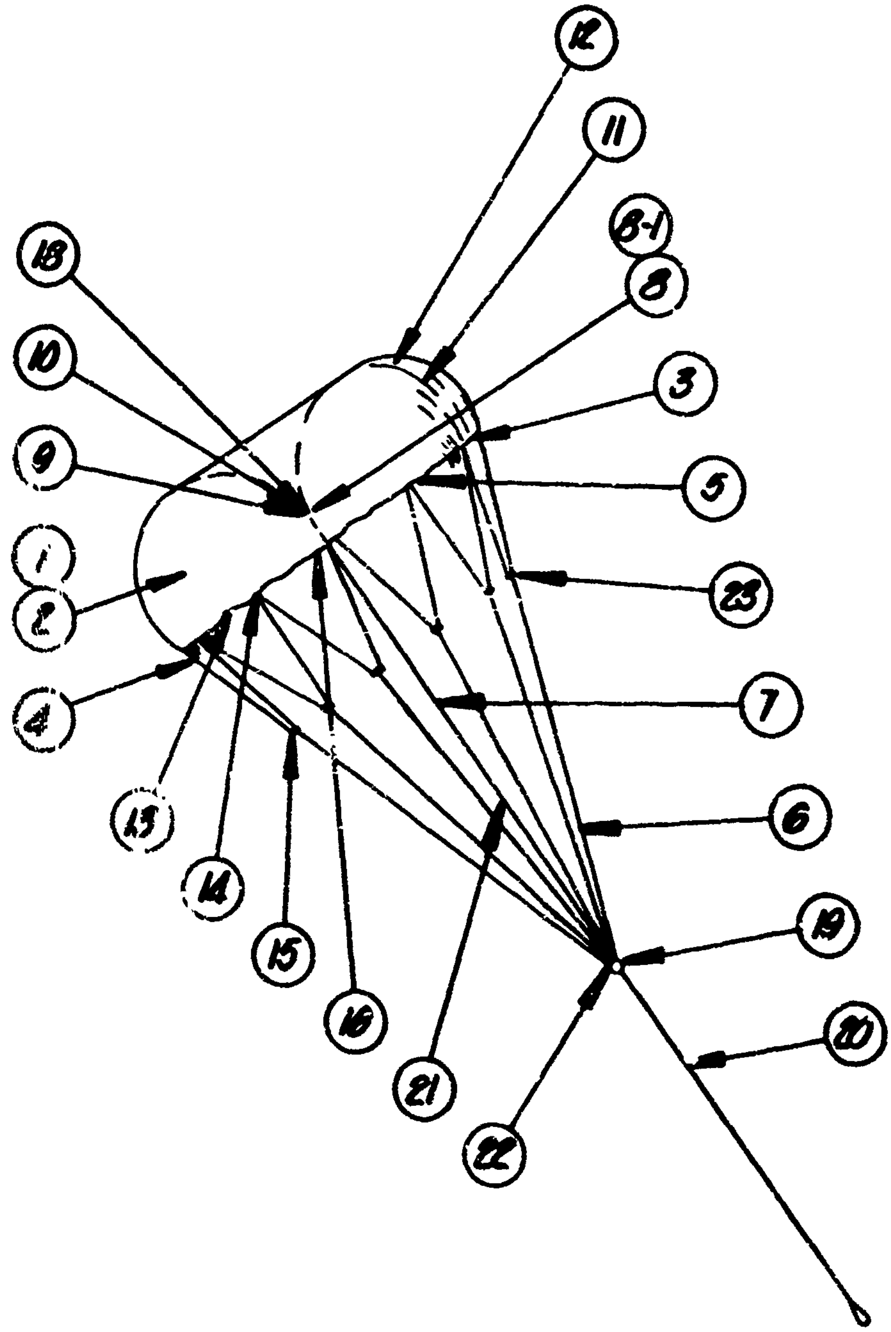

Fig. A-1. Key to laboratory-test reports, E-0154, TL series for 135-ft Nom. Dia. cargo parachute, N/LABS Dwg. No. X11-1-1644.

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LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO.	TEST NO.
Nylon Cloth, control sample MIL-C-7020, Ty. II	E-0154	TL/1

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [ ] EFFICIENCY [ ] OTHER

TEST METHOD Test in accordance with Federal Specification CCC-T-191b, method 5104. Use Scott Tester, Model J-3, 110-lb capacity with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/21/68	RAT	11/21/68

TABLE

Ult. Strength, lb/in.

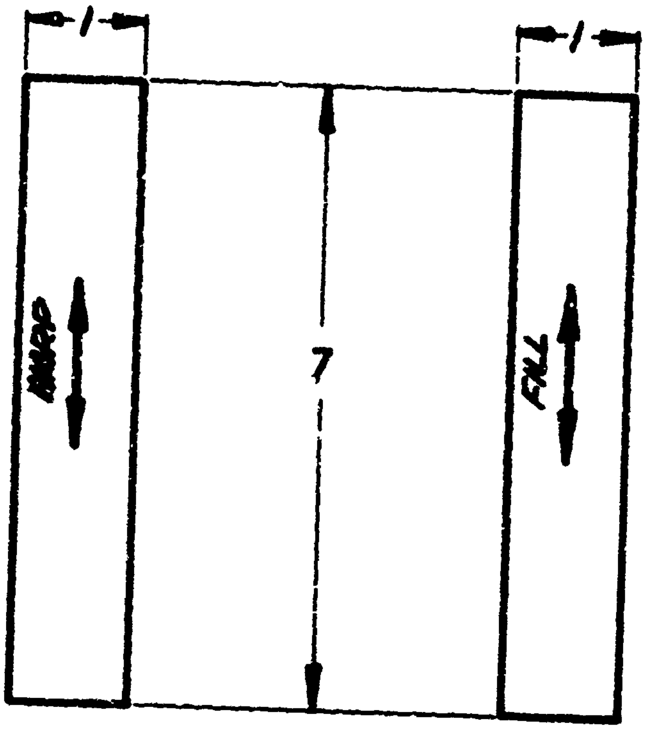
Sample	Warp	Fill
1	63	79
2	69	76
3	71	74
4	70	76
5	71	75
Av.	69	76

COMMENTS

RESULTS All failures occurred over minimum ultimate rated strength.

CONCLUSIONS

TESTED BY La Rivere 11/22/68 DATE COMPLETED



NOTE: SPECIMENS THREADED TO
ABOVE DIMENSIONS

NYLON CLOTH CONTROL SAMPLE

SKETCH E-0154, TL/1

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. E-0154 / TEST NO. TL/2
Nylon cloth, control sample MIL-C-7020, Ty. II Bias-Cut	PROJECT NO. E-0154 TEST NO. TL/2

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [ ] EFFICIENCY [ ] OTHER

TEST METHOD Similar to Federal Specification CCC-T-191b, Method 5100, except test 5 samples cut on the bias. Use Tinius Olsen Testing Machine, 500 lb scale, with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/15/68	RAT	11/15/68

TABLE

Sample	F, lb	Ult. bias strength, lb/in
1	124.8	124.8
2	124.2	124.2
3	173.0	173.0
4	129.6	129.6
5	131.4	131.4
Av.	136.6	136.6

COMMENTS

1. Ultimate bias strength is calculated using the following relationship:

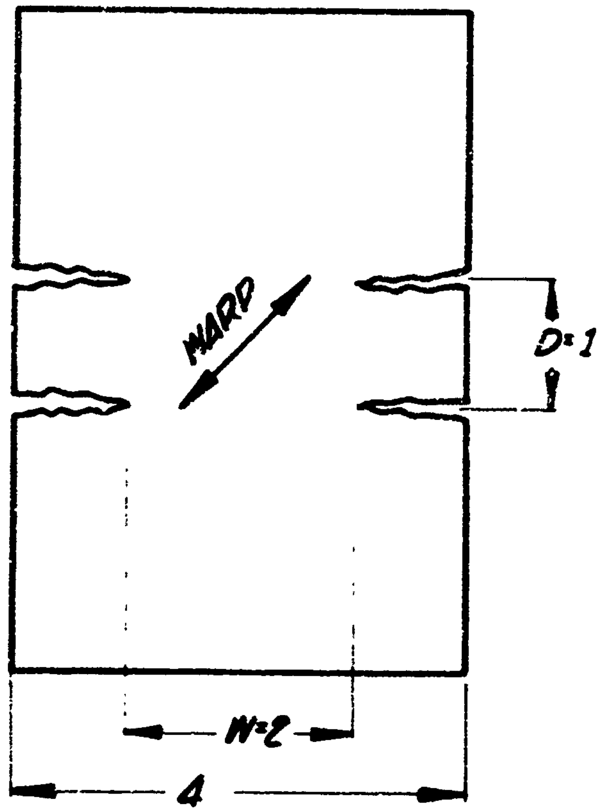
$$\text{Ult. bias} = \frac{F}{W-D},$$

where F is the ultimate strength of the sample, lb; W is original width of the test specimen, in.; and D is the initial jaw separation, in.

RESULTS

CONCLUSIONS

TESTED BY M. M. Knor 11/26/68 DATE COMPLETED



NYLON CLOTH, BIAS-CUT CONTROL SAMPLE

SKETCH E-0154, TL/12

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED Reefing Line, control sample Spec. MIL-C-7575, Ty. VII	PROJECT NO. E-0154 TEST NO. TL/3

PURPOSE ☒ ULTIMATE STRENGTH ☐ POINT OF FAILURE ☐ EFFICIENCY ☐ OTHER

TEST METHOD Same as Federal Specification CCC-T-191b, Method 4102, except test 5 samples and report to the nearest 5 pounds. Use Tinius Olsen Testing Machine 12,C00 lb capacity with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	10/16/68	RAT	10/16/68

TABLE

Sample	Ult. Strength, lb.
1	2755
2	2680
3	2800
4	2730
5	2780
Av.	2749

COMMENTS

RESULTS
All failures occurred over min. ultimate rated strength.

CONCLUSIONS

TESTED BY K. Hinkle 10/17/68 DATE COMPLETED 10/18/68

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED Nylon Cord, control sample MIL-C-5040, Ty. III	PROJECT NO. E-0154 TEST NO. TL/4
PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [ ] EFFICIENCY [ ] OTHER	
TEST METHOD Test in accordance with Federal Specification CCC-T-191b, Method 4102. Use Tinius Olsen Testing Machine 2400 lb capacity with 12 in/min load rate.	

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/21/68	RAT	11/21/68

TABLE

Sample	Ult. Strength, lb.
1	640
2	575
3	582
4	580
5	580
Av.	591

COMMENTS

RESULTS All failures occurred over minimum ultimate rated strength.

CONCLUSIONS

TESTED BY La Rivere 11/25/68 DATE COMPLETED

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. E-0154
Nylon Web, control sample MIL-W-5625, 1 W 4000 lb t.s.	TEST NO. TL/5

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [ ] EFFICIENCY [ ] OTHER

TEST METHOD Test in accordance with Federal Specification CCC-T-191b, Method 5100. Use Tinius Olsen Testing Machine, 12000 lb capacity, with 4 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/21/68	RAT	11/21/68

TABLE

Sample	Ult. strength, lb
1	4710
2	4600
3	4550
4	4520
5	4610
Av.	4598

COMMENTS

RESULTS All specimens failed above min. rated strength.

CONCLUSIONS

TESTED BY La Rivere 11/25/68

DATE COMPLETED

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. / TEST NO.
Nylon Web, control sample 1 W MIL-W-27265, Ty. XVIII, Cl R, 6000 lb t.s.	PROJECT NO. E-0154 TEST NO. TL/6

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [ ] EFFICIENCY [ ] OTHER

TEST METHOD Test in accordance with Federal Specification CCC-T-191b, Method 5100. Use Tinius Olsen Testing Machine, 12,000 lb capacity, with 4 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/4/68	RAT	11/4/68

TABLE

Sample	Ult. strength, lb
1	7250
2	7259
3	7251
Av.	7253

COMMENTS

RESULTS All specimens failed above the minimum rated strength.

CONCLUSIONS

TESTED BY La Riviere 11/5/68 DATE COMPLETED

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO.	E-0154
Nylon Web, control sample 1 3/4 W, MIL-W-27265, Ty. XXVI, Cl R, 15,000 lb t.s.	TEST NO.	TL/7

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [ ] EFFICIENCY [ ] OTHER

TEST METHOD
Test in accordance with Federal Specification CCC-T-191b, Method 5100. Use Tinius Olsen Testing Machine 60,000 lb cap

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/4/68	RAT	11/4/68

TABLE

Sample	Ult. strength, lb
1	15,500
2	15,520
3	15,517
Av.	15,512

COMMENTS

RESULTS
All specimens failed above minimum rated strength.

CONCLUSIONS

TESTED BY La Riviere 11/5/68 | DATE COMPLETED

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO.	TEST NO.
Attachment, vent line to vent ring	E-0154	TL/8

PURPOSE ☒ ULTIMATE STRENGTH ☒ POINT OF FAILURE ☒ EFFICIENCY ☐ OTHER

TEST METHOD Use Tinius Olsen Testing Machine, 2,400 lb capacity, with 12 in/min load rate. Fabricate and test 5 samples per attached sketch. Report results to the nearest pound.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	10/18/68	RAT	10/18/68

TABLE

Sample	Ult. strength, lb
1	658
2	752
3	706
4	722
5	740
Av.	716

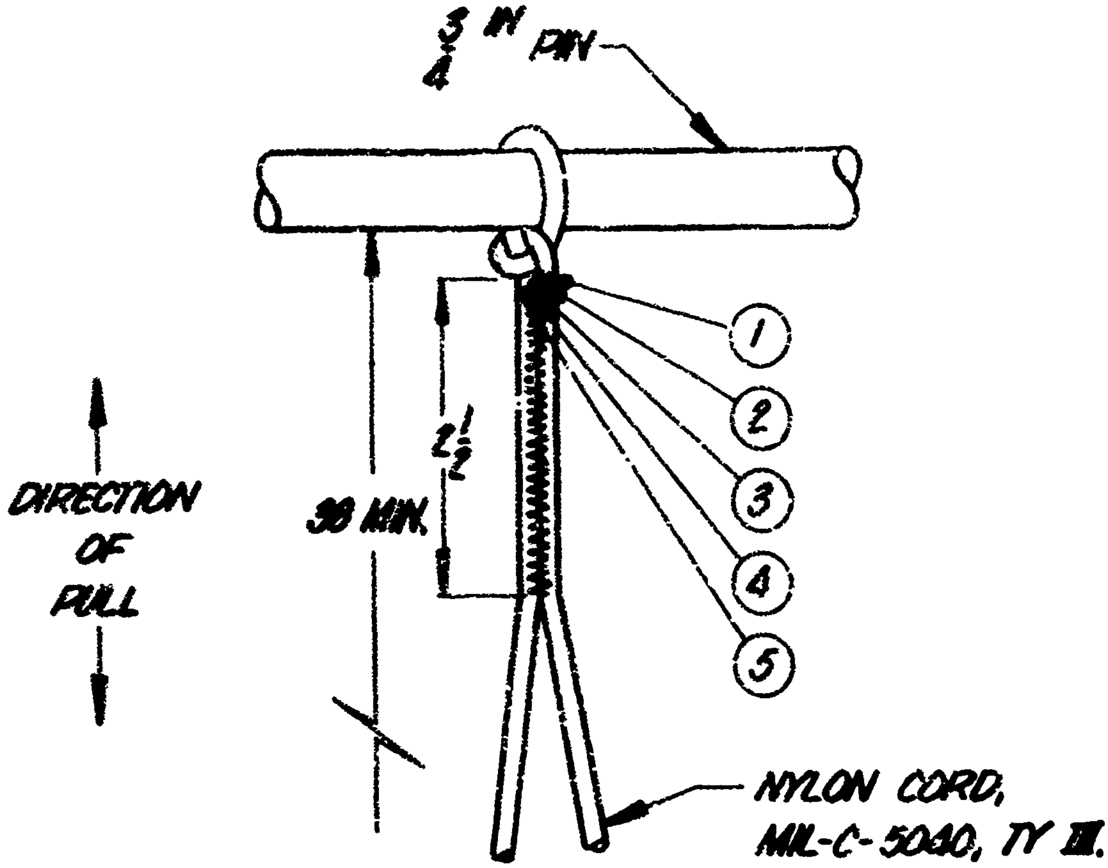
COMMENTS

See sketch for zone of failure.

RESULTS Joint efficiency is: 100 × (Av. ult. strength of joint/Av. ult. strength of cord) = 100 (716/1182) = 60%.

CONCLUSIONS Efficiency of the joint is less than expected. Eliminate the knot and repeat the test.

TESTED BY	DATE COMPLETED
K. Hinkle 10/18/68	



NOTE: ZIG-ZAG STITCHING SHALL BE 7-12 ST/IN COUNTING ON THE SIDE ROW WITH NYLON SIZE "E" THREAD USING A 2 STEP MACHINE. STITCHING SHALL BE 1/8 $^{+1/16}_{-0}$ WIDE.

LINE ATTACHMENT TO VENT RING

SKETCH E-0154, TL/8

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO.
Attachment, vent line to vent ring. Ref. NALABS Dwg. no. X11-1-1646, Detail K	R-0154
	TEST NO. TL/8-1

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD Use Tinius Olsen Testing Machine with 12 in/min load rate. Fabricate 5 samples and test per attached sketch. Report the results to the nearest pound.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
HMK	10/18/68	RAT	10/18/68

TABLE

Sample	Ult. strength, lb
1	1,050
2	996
3	1,048
4	1,032
5	998
Av.	1,025

COMMENTS

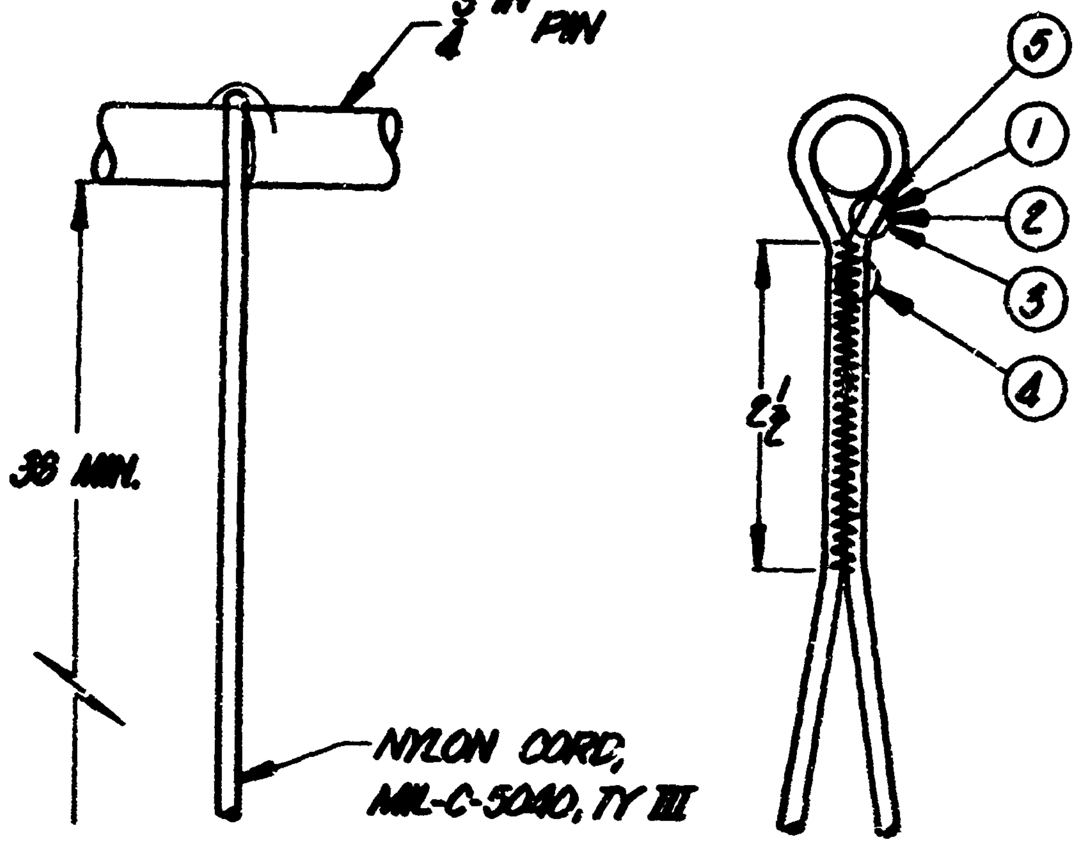
See attached sketch for zone of failure.

RESULTS

Efficiency of joint is: 100 × (Av. ult. strength of joint/Av. ult. strength of cord) = 100 (1025/1182) = 87%.

CONCLUSIONS Ultimate strength of the attachment is acceptable for intended application.

TESTED BY K. Hinkle 10/18/68 DATE COMPLETED



NOTE: ZIG-ZAG STITCHING SHALL BE 7-12 ST/IN COUNTING ON THE SIDE ROW WITH NYLON SIZE "E" THREAD USING A 2 STEP MACHINE. STITCHING SHALL BE $1/8 \; {}^{+1/16}_{-0}$ WIDE.

LINE ATTACHMENT TO VENT RING

SKETCH E-0154, TL/18-1

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED Attachment, vent line to vent band. Ref. NALABS Dwg. no. X11-1-1645, Detail C		PROJECT NO. E-0154 TEST NO. TL/9	
PURPOSE [X] ULTIMATE STRENGTH [X] POINT OF FAILURE [X] EFFICIENCY [ ] OTHER			
TEST METHOD Same as Federal Specification CCC-T-191b, Method 4102 except fabricate 5 samples and pull per attached sketch. Use Tinius Olsen Testing Machine, 2,400 lb capacity with 12 in/min load rate and report to the nearest pound.			
REQUESTED BY MMK	DATE REQUESTED 10/2/68	REQUEST APPD. BY RAT	DATE APPROVED 10/3/68

TABLE

Sample	Ult. strength, lb
1	636
2	638
3	620
4	632
5	640
Av.	633

COMMENTS

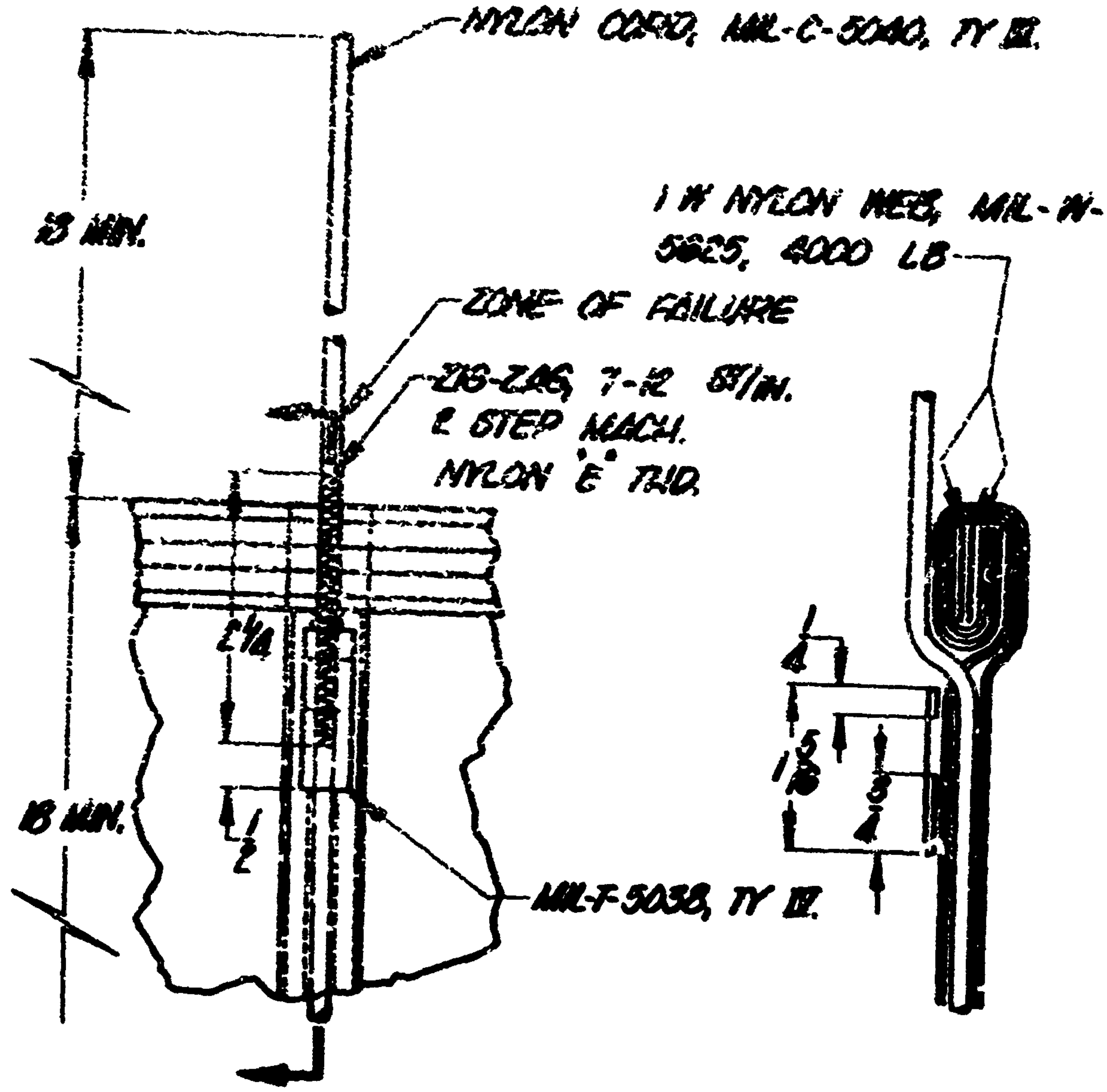
See sketch for zone of failure.

RESULTS

Joint efficiency is: 100 × (Av. ult. strength of joint/Av. ult. strength of cord) = 100 (633/591 lb) = 107%.

CONCLUSIONS Ultimate strength of the joint is acceptable for intended application.

TESTED BY M. M. Knor 10/9/68 | DATE COMPLETED



NOTE: MACHINE STITCHING UNLESS OTHERWISE SPECIFIED SHALL BE TYPE 301, FED STD 751 8-12 ST/IN WITH NYLON SIZE "E" THD.

VENT LINE ATTACHMENT

SKETCH E-0154, TL/10

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO.	E-0154
Nom, vent band. Ref. NALABS Dwg. No. X11-1-1645, Detail C	TEST NO.	TL/10

PURPOSE ☒ ULTIMATE STRENGTH ☐ POINT OF FAILURE ☒ EFFICIENCY ☐ OTHER

TEST METHOD Use Tinius Olsen Testing Machine, 12,000 lb capacity, with 12 in/min load rate. Test same as Federal Specification CCC-T-191b, Method 4102, except fabricate 5 samples and pull per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MNK	10/2/68	RAT	10/3/68

TABLE

Sample	Ult. strength, lb
1	8580*
2	8540**
3	8580
4	8220
5	8650***
Av.	8514

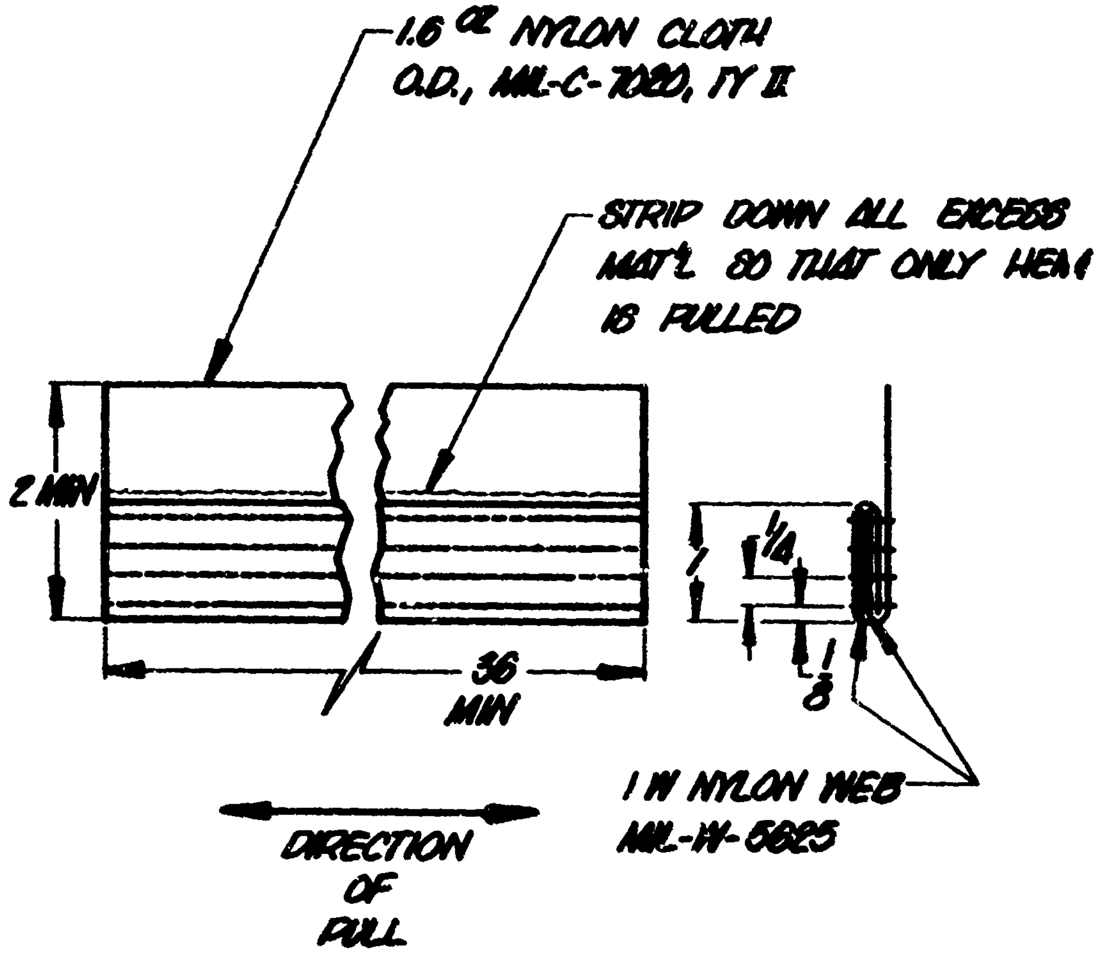
COMMENTS

* Preloaded to 5400 lb
** Preloaded to 4950 lb
*** Preloaded to 6500 lb

RESULTS Efficiency of joint is: 100 × Av. ult strength of joint/(Av. ult strength of webbing × 2) = 100 (8514/9196) = 93%.

CONCLUSIONS Ultimate strength of vent band is acceptable for intended application.

TESTED BY M.M. Knor 10/9/68 | DATE COMPLETED



NOTE: MACHINE STITCHING SHALL BE TYPE 301
FED STD 751 8-11 ST/IN WITH NYLON SIZE "E"
THD.

HEM, VENT BAND

SKETCH E-0154, TL/10

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. / TEST NO.
Joint (on the bias), main seam Ref. NALABS Dwg. No. X11-1-1645, Detail A	PROJECT NO. E-0154
	TEST NO. TL/11

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD Same as Federal Specification CCC-T-191b, Method 5100, except fabricate and test 6 samples per attached sketch. Use Tinius Olsen Testing Machine, 600 lb capacity with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/18/68	RAT	11/18/68

TABLE

Sample	F, lb	Ult. bias Strength lb/in.
1	128.0	128.0
2	125.0	125.0
3	119.0	119.0
4	167.0	167.0
5	146.0	146.0
6	119.0	119.0
Av.	134.0	134.0

COMMENTS

1. Ultimate bias strength is calculated using the following relationship:

Ult. bias strength = $\frac{F}{W-D}$,

where F is the ultimate strength of the sample, lb; W is original width of the specimen, in.; and D is the initial jaw separation, in.

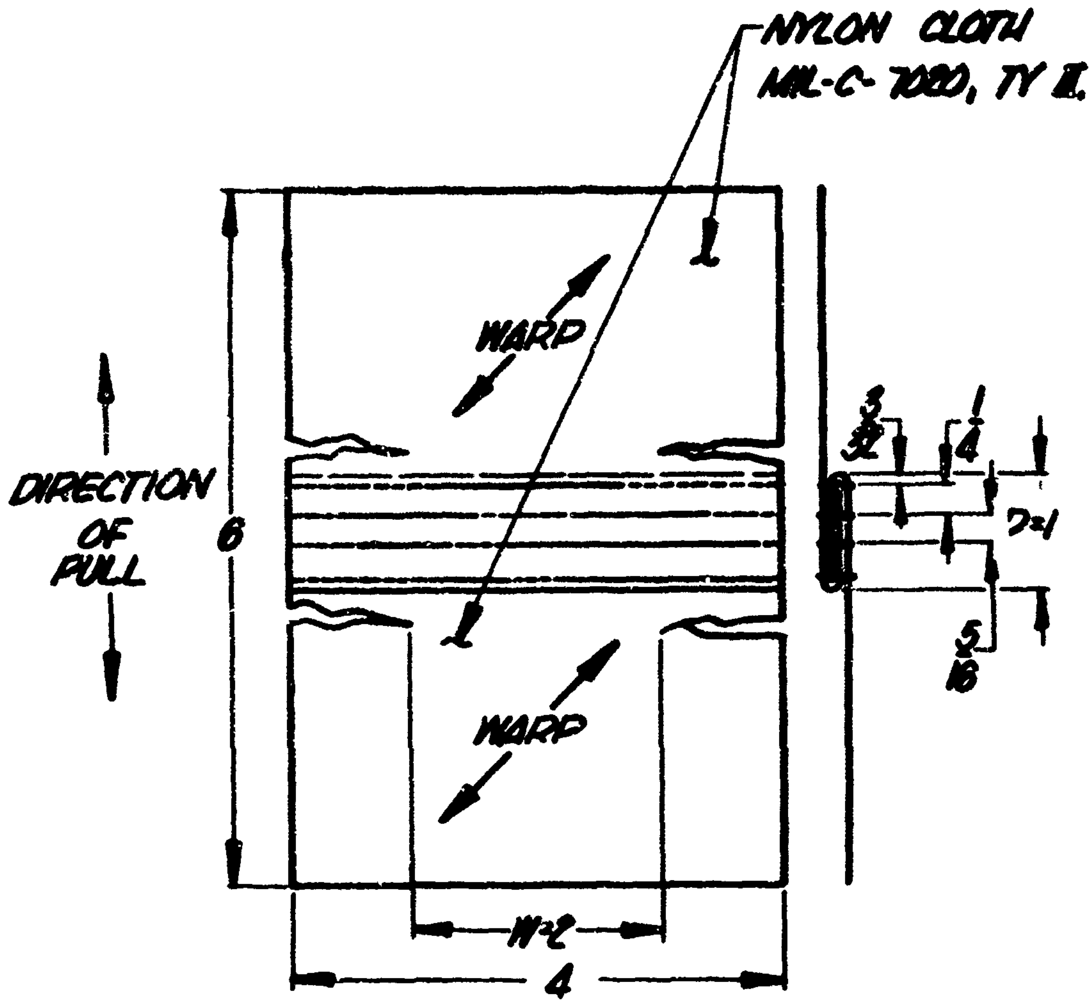
RESULTS

1. Efficiency of the joint is: 100 × (Av. ult. bias strength of joint/Av. ult. bias strength of cloth) = 100 (134/136.6) = 98%.

2. Efficiency of the joint is: 100 × (min. ult. bias strength of joint/min ult. bias strength of cloth) = 100 (119.0/124.2) = 95.8%.

CONCLUSIONS Ultimate strength of main seam is acceptable for intended application.

TESTED BY	DATE COMPLETED
M. M. Knor 11/20/68	



NOTE: MACHINE STITCHING SHALL BE TYPE 301 FED STD 751 8-11 ST/IN WITH NYLON SIZE "E" THD.

JOINT (ON THE BIAS), MAIN SEAM

SKETCH E-0154, TL/N

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED Joint, Cross Seam Ref. NALABS Dwg. No. X11-1-1645, Detail A	PROJECT NO. E-0158 TEST NO. TL/12

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD Same as Federal Specification CCC-T-191b, Method 5100, except to be fabricated and tested per attached sketch. Use Tinius Olsen Testing Machine, 600 lb scale with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/15/68	RAT	11/15/68

TABLE

Sample	Ult. strength, lb*
1	121.0
2	111.0
3	129.0
4	119.0
5	117.0
6	123.0
Av.	120.0

* For 2 in. test section

COMMENTS

Since test section is 2 in.,

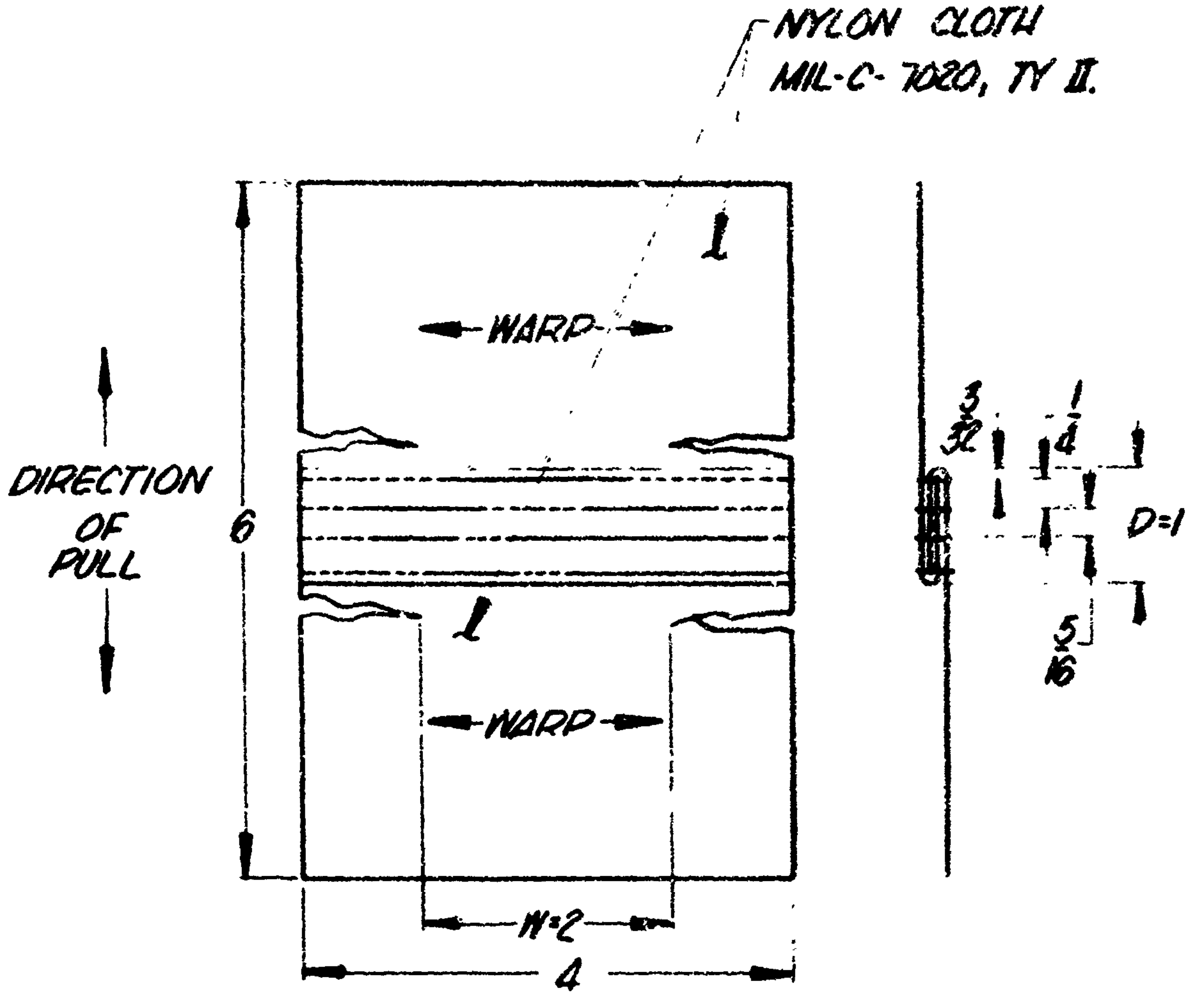
$\frac{Av.}{2}$ = Av. strength for 1 in. section of seam.

RESULTS Average ultimate strength of control sample of cloth in the fill direction is 76 lb/in (See test - TL/1).

Efficiency of joint is: 100 × (Av. ult. strength of joint/Av. ult. strength of cloth) = 100 (60/76) = 79%.

CONCLUSIONS
Ultimate strength of cross seam is acceptable for intended application.

TESTED BY M. M. Knor 11/20/68 DATE COMPLETED



NOTE: MACHINE STITCHING SHALL BE TYPE 301 FED STD 751 8-11 ST/IN WITH NYLON SIZE "E" THD.

JOINT, CROSS SEAM

SKETCH E-0154, TL/12

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED Hem, skirt band Ref. NALABS Dwg. no. X11-1-1645, Detail B	PROJECT NO. E-0154 TEST NO. TL/13

PURPOSE [x] ULTIMATE STRENGTH [ ] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD
Use Tinius Olsen Testing Machine, 12,000 lb capacity with 12 in/min load rate. Test same as Federal Specification CCC-T-191b, Method 4102, except fabricate 5 samples and test as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	10/2/68	RAT	10/3/68

TABLE

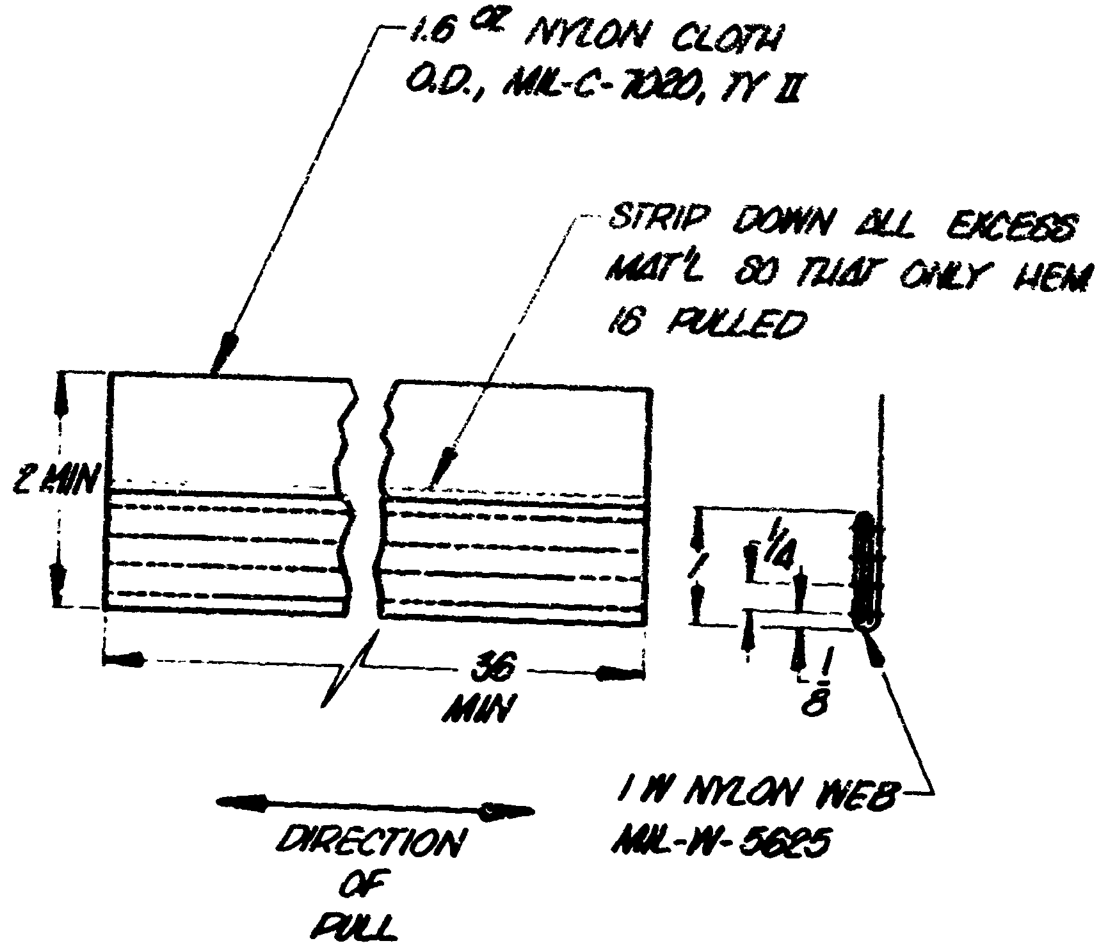
Sample	Ult. strength, lb
1	4620*
2	4475**
3	4680
4	4530
5	4565
Av.	4574

COMMENTS
* Repeated test
** Preloaded to 1630 lb

RESULTS
Efficiency of joint is: 100 × (Av. ult. strength of joint/Av. ult. strength of web) = 100 (4574/4598) = 99%.

CONCLUSIONS
Ultimate strength of skirt band is acceptable for application intended.

TESTED BY	DATE COMPLETED
M. M. Knor 10/4/68	



NOTE: MACHINE STITCHING SHALL BE TYPE 301 FED STD 751 8-11 ST/IN WITH NYLON SIZE "E" THD.

HEM, SKIRT BAND

SKETCH E-0154, TL/13

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. / TEST NO.
Attachment, suspension line to skirt. Ref. NALABS Dwg. no. X11-1-1645, Detail B	PROJECT NO. E-0154 TEST NO. TL/14

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD Same as Federal Specification CCC-T-191b, Method 4102, except fabricate 5 samples and test per attached sketch. Use Tinius Olsen Testing Machine, 2400 lb capacity with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	10/2/68	RAT	10/3/68

TABLE

Sample	Ult. strength, lb
1	600
2	584
3	600
4	576
5	592
Av.	590

COMMENTS

See attached sketch for zone of failure.

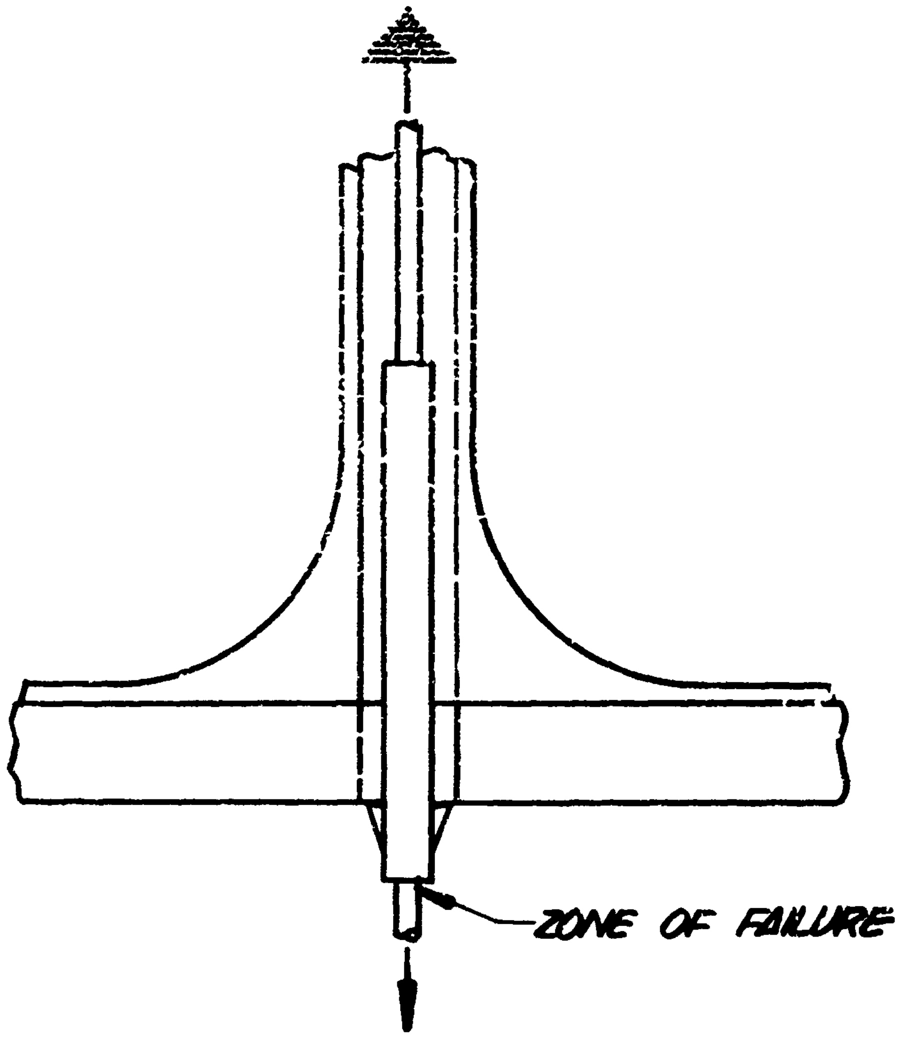
RESULTS

Data indicate that joint is 100% efficient and no loss of structural integrity of the suspension line occurred.

CONCLUSIONS

Ultimate strength of the joint is acceptable for application intended.

TESTED BY M. M. Knor 10/9/68 DATE COMPLETED



DIRECTION OF PULL

SEE DWG NO XII-1-1645 FOR DETAILS OF MATERIALS AND JOINING.

ATTACHMENT, SUSPENSION LINE TO SKIRT

SKETCH E-0154, TL/14

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. / TEST NO.
Attachment, suspension line to link. Ref. NALABS Dwg. no. X11-1-1648	PROJECT NO. E-0154 TEST NO. TL/15

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD

Use Tinius Olsen Testing Machine, 2400 lb capacity with 12 in/min load rate. Fabricate 5 samples and test as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	10/21/68	RAT	10/21/68

TABLE

Sample	Ult. strength, lb
1	592
2	558
3	588
4	558
5	574
Av.	574

COMMENTS

See attached sketch for zone of failure.

Samples 1, 3, 4 and 5 failed in zone A.

Sample 2 failed in zone B.

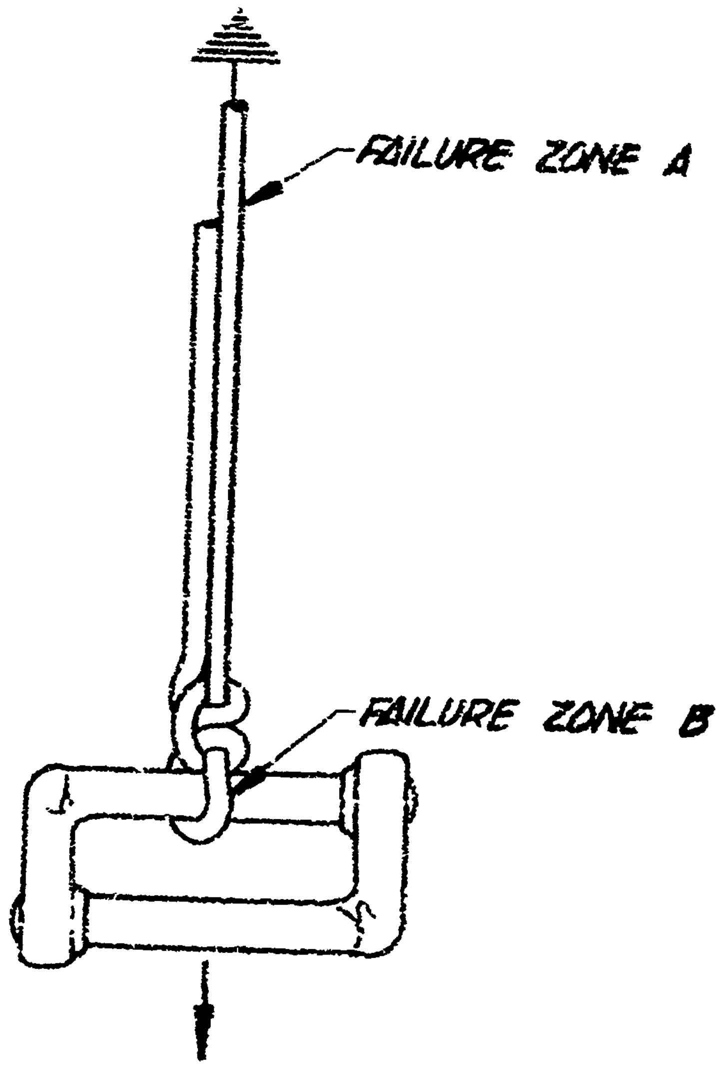
RESULTS

Efficiency of joint is: 100 = (Av. ult. strength of joint/Av. ult. strength of cord) × 100 (574/591) = 97%.

CONCLUSIONS

Ultimate strength of joint is acceptable for intended application.

TESTED BY	DATE COMPLETED
K. Hinkle 10/22/68	



SEE DWG NO XII-1-1648 FOR DETAILS OF MATERIALS AND JOINING.

SKETCH E-0154, TL/15

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. / TEST NO.
Attachment reefing ring. Ref. NALABS Dwg. no. X11-1-1646, Detail H.	PROJECT NO. E-0154 TEST NO. TL/16

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [ ] EFFICIENCY [ ] OTHER

TEST METHOD

Use Tinius Olsen Testing Machine 600 lb capacity with 12 in/min load rate. Fabricate 5 samples and test as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/8/68	RAT	11/8/68

TABLE

Sample	Ult. strength, lb
1	405
2	404
3	378
4	203*
5	425
Av.	403

COMMENTS

* Indicates jaw break.

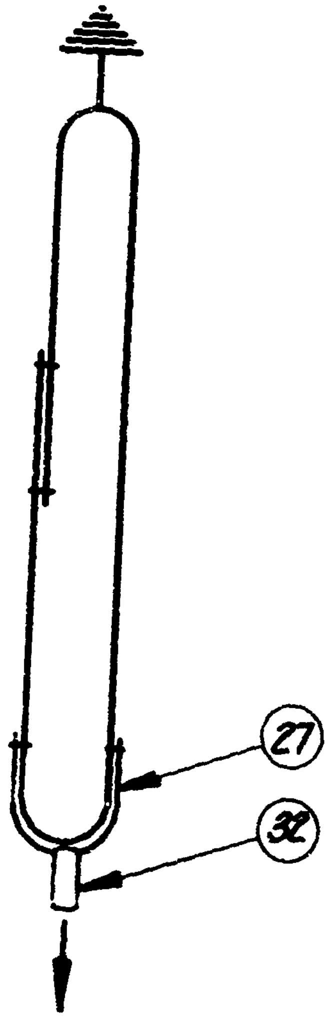
RESULTS

Reefing ring pt. no. 48A7995 failed during each test.

CONCLUSIONS

Ultimate strength of attachment is acceptable for application intended.

TESTED BY M. M. Knor 11/14/68 DATE COMPLETED



DIRECTION OF PULL

SEE DWG NO XII-1-1646 FOR DETAILS OF MATERIALS
AND JOINING.

SKETCH E-0154, TL/16

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. E-0154
Joint, reefing line splice	TEST NO. TL/17

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD

Build and test 5 samples. Use Tinius Olsen Testing Machine, 12,000 lb capacity with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	10/17/68	RAT	10/17/68

TABLE

Sample	Ult. strength, lb
1	5610
2	5670
3	5680
4	5680
5	5760
Av.	5680

COMMENTS

RESULTS

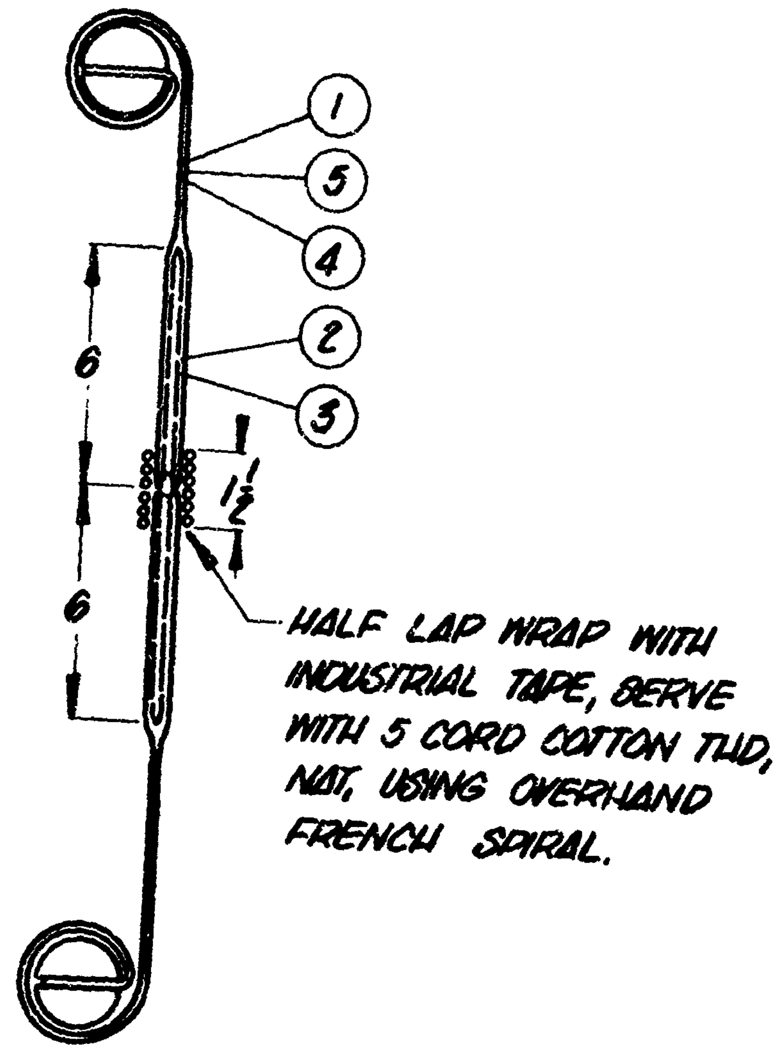
Average ultimate strength of control sample is 2,749 lb (see test TL/3).

Efficiency of the joint is: 100 × (Av. ult. strength of joint/Av. ult. strength of cord) = 100 (5680/5498) = 103.3%.

CONCLUSIONS

Efficiency is relatively high. Retest using different test set up.

TESTED BY K. Hinkle 10/17/68	DATE COMPLETED 10/21/68



JOINT, REEFING LINE SPLICE

SKETCH E-0154, TL/17-1

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. F-0154
Joint, reefing line splice	TEST NO. TL/17-1

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD

Build and test 5 samples as per attached sketch. Use Tinius Olsen Testing Machine, 12,000 lb capacity with 12 in/min load rate.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	11/20/68	RAT	11/20/68

TABLE

Sample	Ult. strength, lb
1	2640
2	2840
3	2550
4	2580
5	2600
Av.	2642

COMMENTS

See sketch for zone of failure.

Average ultimate strength of control sample is 2749 lb (see test TL/3)

RESULTS

1. Efficiency of the joint is: 100 × (Av. ult. strength of joint/Av. ult. strength of control sample) = 100 (2642/2749) = 96%.

2. Efficiency of the joint is: 100 × (Min. t.s. of joint/Min. t.s. of control sample) = 100 (2550/2680) = 95%.

CONCLUSIONS

Ultimate strength of splice is acceptable for intended application.

TESTED BY M.M. Knor 11/21/68	DATE COMPLETED

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED
Attachment, center line to vent ring. Ref. NALABS Dwg. no. X11-1-1650

PROJECT NO. E-0154

TEST NO. TL/18

PURPOSE [x] ULTIMATE STRENGTH [x] PO. F FAIL. [x] EFFICIENCY [ ] OTHER

TEST METHOD
Use Tinius Olsen Testing Machine, 60,000 lb capacity with 4 in/min load rate. Fabricate 4 samples and test as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	12/12/68	RAT	12/12/68

TABLE

Sample	Ult. strength, lb
1	27,050
2	27,300
3	24,600
4	24,600
Av.	25,887.5

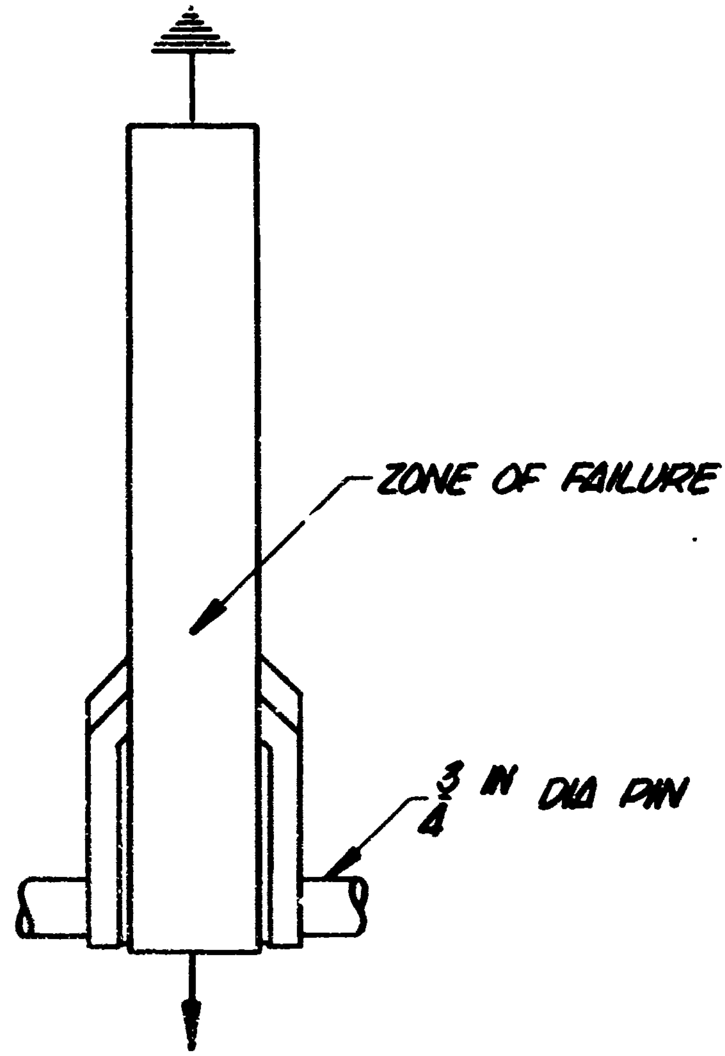
COMMENTS
See attached sketch for the zone of failure.

RESULTS
Efficiency of the joint is: 100 × (Av. ult. strength of joint/Av. ult. strength of control sample) = 100 (25,887.5/31,024) = 83.4%.

CONCLUSIONS
Ultimate strength of joint is acceptable for intended application.

TESTED BY M.M. Knor 12/23/68

DATE COMPLETED



SEE DWG NO XII-1-1650 FOR DETAILS OF MATERIALS AND JOINING.

ATTACHMENT, CENTER LINE TO VENT RING

SKETCH E-0154, TL/18

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. E-0154 / TEST NO. TL/19
Attachment, center line to clevis Ref. NALABS Dwg. no. X11-1-1650	PROJECT NO. E-0154 TEST NO. TL/19

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD

Use Tinius Olsen Testing Machine, 60,000 lb capacity with 4 in/min load rate. Fabricate 3 samples and test as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	12/12/68	RAT	12/12/68

TABLE

Sample	Ult. strength, lb
1	28,800
2	28,450
3	28,000
Av.	28,410

COMMENTS

See attached sketch for the zone of failure.

During each test jaw break occurred at the upper fixture.

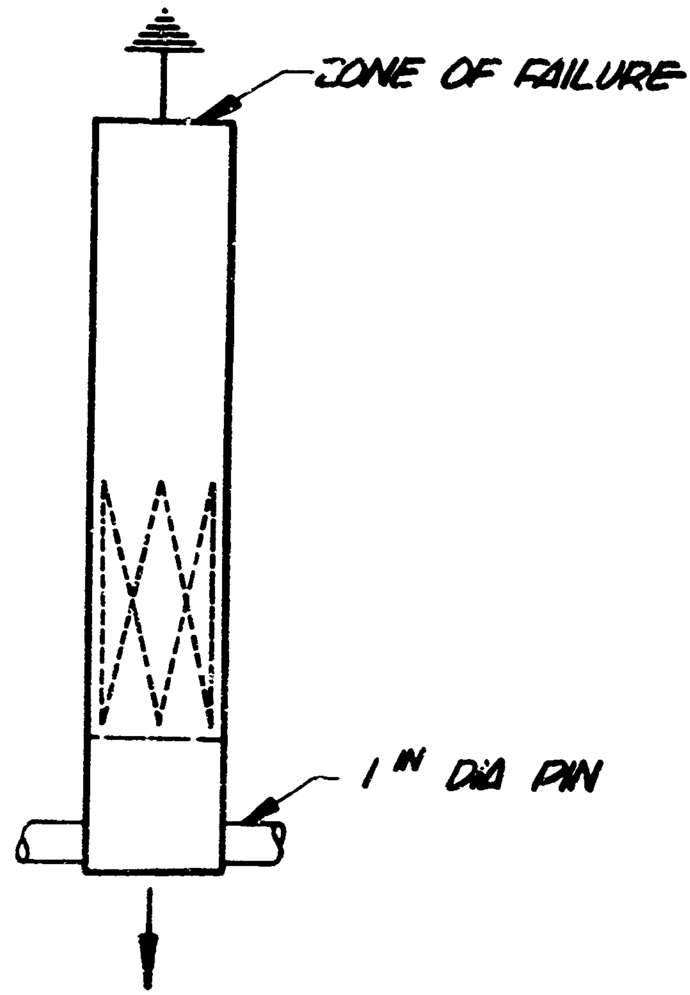
RESULTS

Data obtained during the test indicate that the joint is 93% efficient. Owing to the jaw breaks it can be assumed that efficiency is actually better than indicated above.

CONCLUSIONS

Attachment is acceptable for application intended.

TESTED BY M.M. Knor 12/23/68 | DATE COMPLETED



SEE DWG NO XII-1-1646 FOR DETAILS OF MATLS AND JOINING.

ATTACHMENT, CENTERLINE TO CLEVIS

SKETCH E-0154, TL/19

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED Riser extension splice	PROJECT NO. E-0154 TEST NO. TL/20
PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER	
TEST METHOD Use Tinius Olsen Testing Machine 60,000 lb capacity with 4 in/min load rate. Fabricate and test 5 samples as per attached sketch.	

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	12/12/68	RAT	12/12/68

TABLE

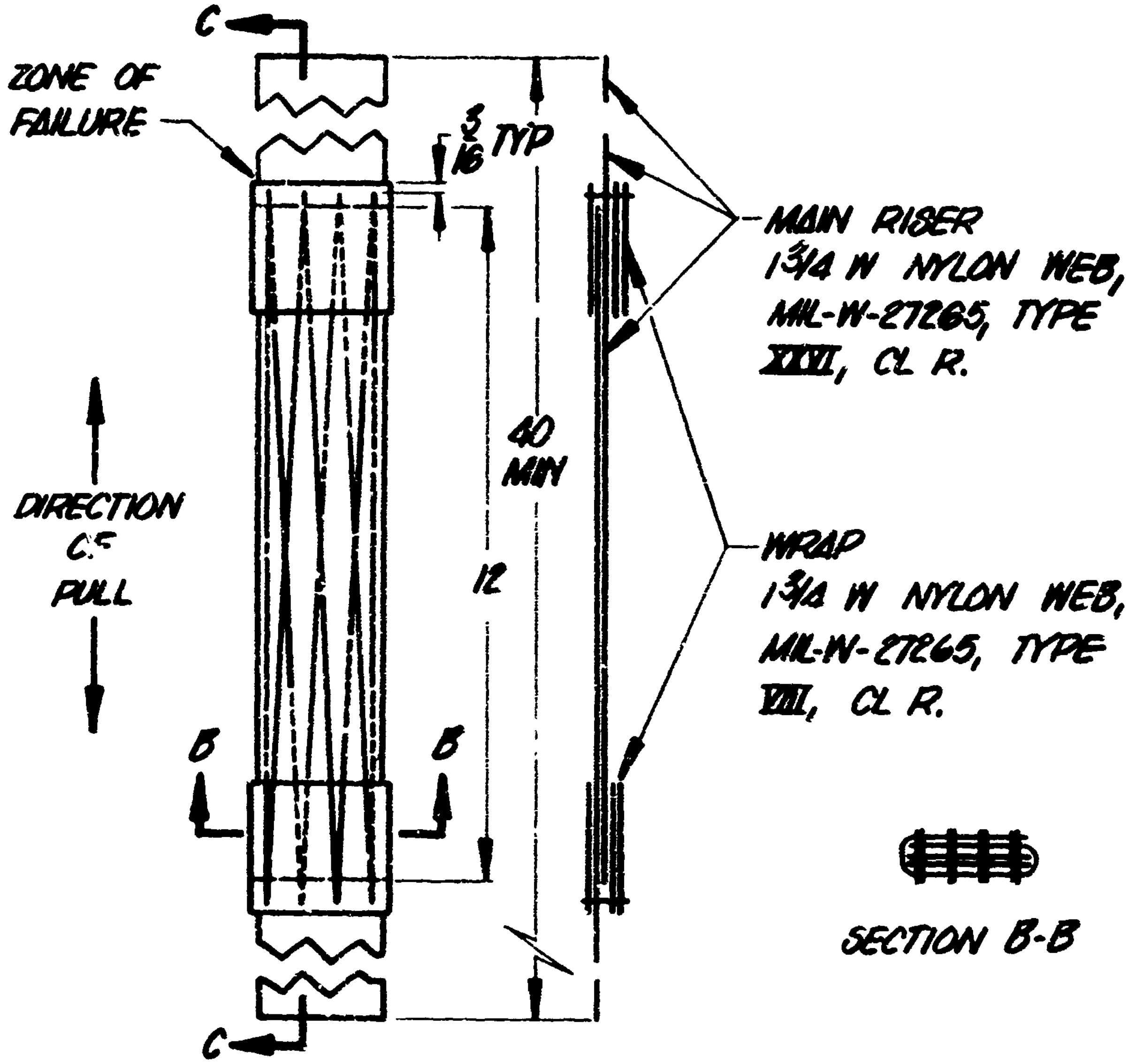
Sample	Ult. strength, lb
1	13,350
2	13,500
3	13,700
4	13,550
5	13,600
Av.	13,540

COMMENTS

RESULTS
Joint efficiency is: 100 × (Av. ult. strength of joint/Av. ult. strength of control sample) = 100 (13,540/15,512) = 87%.

CONCLUSIONS
Ultimate strength of splice is acceptable for intended application.

TESTED BY M.M. Knor 12/18/68	DATE COMPLETED



SECTION C-C

MACHINE STITCHING TYPE 301, FED STD 751, 5 TO 8 STITCHES PER INCH WITH NYLON 6 CORD THREAD.

RISER EXTENSION SPLICE

SKETCH E-0154, TL/20

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. E-0154
Center-line splice	TEST NO. TL/21

PURPOSE ☒ ULTIMATE STRENGTH ☒ POINT OF FAILURE ☒ EFFICIENCY ☐ OTHER

TEST METHOD Use Tinius Olsen Testing Machine, 60,000 lb capacity with 4 in/min load rate. Fabricate and test 5 samples as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	12/12/68	RAT	12/12/68

TABLE

Sample	Ult. strength, lb	COMMENTS
1	13,800	Stitching failed.
2	13,900	Web below the stitching.
3	12,200	Stitching failed.
4	12,950	Stitching failed.
5	13,450	Stitching failed.
Av.	13,400	

Refer to sketch E-0154, TL/20 and note for center-line splice, wrap is Ty. XII.

RESULTS

Joint efficiency is: 100 × (Av. ult. strength of joint/Av. ult. strength of control sample) = 100 (13,400/15,512) = 86%.

CONCLUSIONS

Ultimate strength of splice is acceptable for intended application.

TESTED BY M.M. Knor 1/2/69	DATE COMPLETED

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED Attachment, riser to clevis Ref. NALABS Dwg. no. X11-1-1651	PROJECT NO. E-0154 TEST NO. TL/22

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD
Use Tinius Olsen Testing Machine, 50,000 lb capacity with 4 in/min load rate. Fabricate 3 samples and test as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	12/12/68	RAT	12/12/68

TABLE

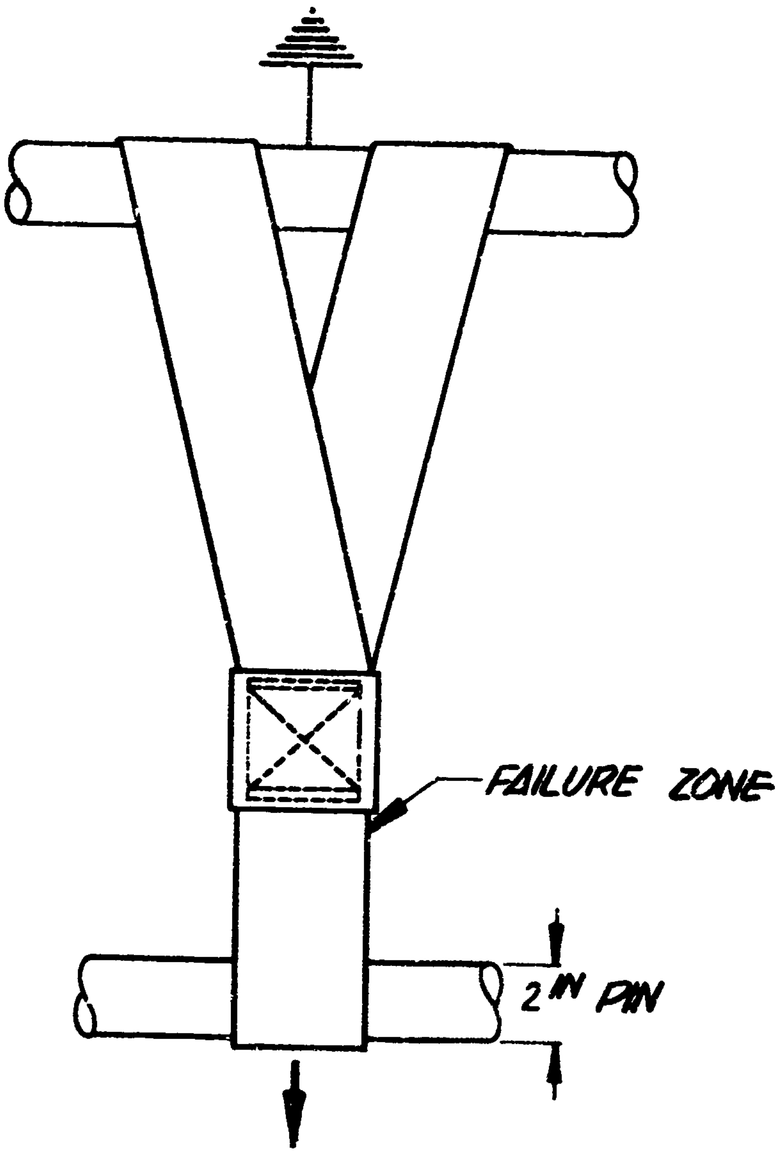
Sample	Ult. strength, lb
1	26,000
2	24,400
3	26,150
Av.	25,517

COMMENTS
See sketch for the zone of failure.

RESULTS
Joint efficiency is: 100 × (Av. ult. strength of joint/Av. ult. strength of control sample) = 100 (25,517/28,012) = 88%.

CONCLUSIONS
Ultimate strength of joint is acceptable for intended application.

TESTED BY M.M. Knor 12/23/68 DATE COMPLETED



SEE DWG NO XII-1-1651 FOR DETAILS OF MATERIALS AND JOINING.

ATTACHMENT, RISER TO CLEVIS

S.ETCH E-0154, TL/22

LABORATORY TEST REQUEST/REPORT

ITEM(S) TO BE TESTED	PROJECT NO. E-0154
Attachment, riser to link Ref. NALABS Dwg. no. X11-1-1651	TEST NO. TL/23

PURPOSE [x] ULTIMATE STRENGTH [x] POINT OF FAILURE [x] EFFICIENCY [ ] OTHER

TEST METHOD Use Tinius Olsen Testing Machine, 12,000 lb capacity with 4 in/min load rate. Fabricate 5 samples and test as per attached sketch.

REQUESTED BY	DATE REQUESTED	REQUEST APPD. BY	DATE APPROVED
MMK	12/12/68	RAT	12/12/68

TABLE

Sample	Ult. strength, lb
1	5,400
2	5,460
3	5,520
4	5,430
5	5,250
Av.	5,412

COMMENTS

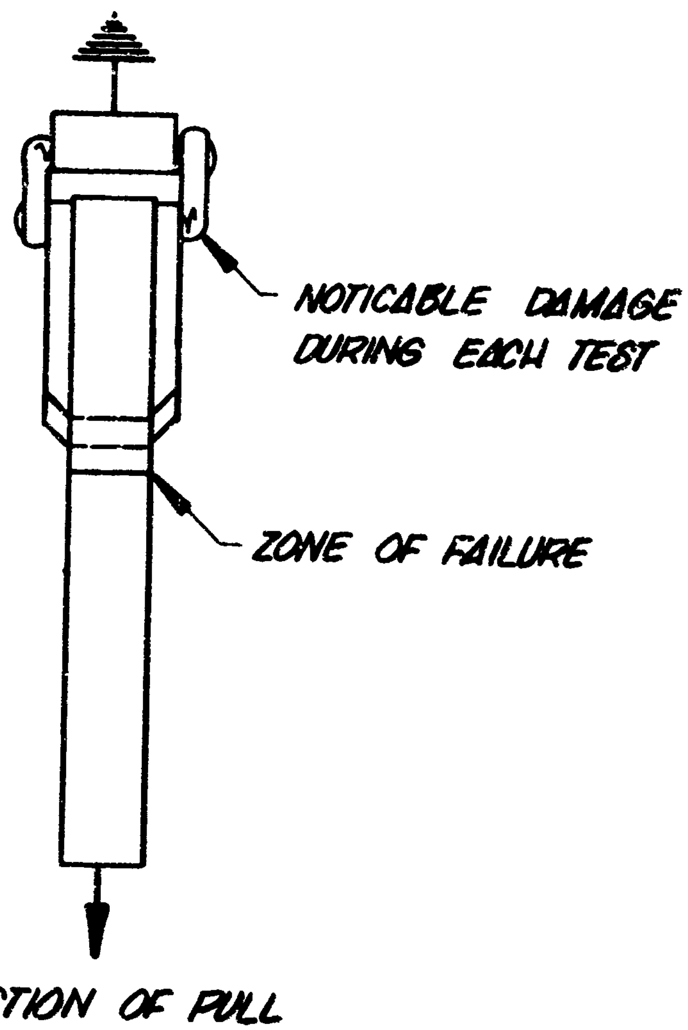
See attached sketch for the zone of failure.

RESULTS

Joint efficiency is: 100 × (Av. ult. strength of joint/Av. ult. strength of control sample) = 100 (5,412/7.253) = 75%.

CONCLUSIONS Ultimate strength of joint is acceptable for intended application.

TESTED BY M.M. Knor 12/18/68 DATE COMPLETED



SEE DWG NO XII-1-1657 FOR DETAILS OF MATERIALS AND JOINING.

ATTACHMENT, RISER TO LINK

SKETCH E-0154, TL/23

APPENDIX B

TRAJECTORY

PIONEER PARACHUTE CO., INC. TWO DEGREE OF FREEDOM TRAJECTORY PROGRAM, POINT MASS, FLAT, NON-ROTATING EARTH. 10/65

E-0154
6-135 FT DIAMETER 4 SEC CUTTER DELAY

CASE	HSUM	VSUM	GAMMA	WEIGHT	CD
5099- 2	1457	253.3	-3	50000	.4000

TIME SEC.	CL1	CD1	CL2	CD2	CL3	CD3	CL4	CD4	TL	TD	WEIGHT	PRINT INT.
1.50	.00	7.00	.00	.00	.00	.00	.00	.00	.00	.00	50000.00	.10
3.30	.00	7.00	.00	2675.00	.00	.00	.00	.00	.00	.00	50000.00	.10
5.40	.00	7.00	.00	2675.00	.00	.00	.00	.00	.00	.00	50000.00	.10
7.40	.00	7.00	.00	17150.00	.00	.00	.00	.00	.00	.00	50000.00	.10
9.30	.00	7.00	.00	17150.00	.00	.00	.00	.00	.00	.00	50000.00	.10
10.00	.00	7.00	.00	50000.00	.00	.00	.00	.00	.00	.00	50000.00	.10
11.10	.00	7.00	.00	30000.00	.00	.00	.00	.00	.00	.00	50000.00	.10
12.00	.00	7.00	[illegible]	38500.00	.00	.00	.00	.00	.00	.00	50000.00	.10
12.60	.00	7.00	[illegible]	64950.00	.00	.00	.00	.00	.00	.00	50000.00	.10
13.30	.00	7.00	.00	91950.00	.00	.00	.00	.00	.00	.00	50000.00	.10
14.20	.00	7.00	.00	64400.00	.00	.00	.00	.00	.00	.00	50000.00	.10
18.60	.00	7.00	.00	100000.00	.00	.00	.00	.00	.00	.00	50000.00	.10
30.10	.00	7.00	.00	74000.00	.00	.00	.00	.00	.00	.00	50000.00	.10
100.00	.00	7.00	.00	74000.00	.00	.00	.00	.00	.00	.00	50000.00	.10

MACH NO.	CLM1	CDM1	CLM2	CDM2	CLM3	CDM3	CLM4	CDM4
.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

T0=	1.50 SEC.	S1=	1.00 SQ. FT.	INTEGRATION INT.=	.01
R0=	437.50 FT.	S2=	1.00 SQ. FT.		
V0=	253.30 FT./SEC.	S3=	1.00 SQ. FT.		
H0=	1457.00 FT.	S4=	1.00 SQ. FT.		
GAM0=	-3.00 DEG.	HS=	.00 FT.		
		TS=	100.00 SEC.		

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	L2	L3	L4
1.5	253.50	1.95	1457.00	-13.28	73.05	-3.00	.23	427.08	.0	.0	.0
1.6	253.14	-5.22	1455.55	-16.44	72.97	-3.73	.23	452.28	10883.6	.0	.0
1.7	252.33	-11.60	1453.74	-19.50	72.80	-4.45	.23	477.40	21549.4	.0	.0
1.8	250.88	-17.09	1451.46	-22.67	71.68	-5.18	.23	502.16	31959.4	.0	.0
1.9	248.81	-23.07	1449.26	-25.60	70.80	-5.92	.22	527.42	41911.2	.0	.0
2.0	246.16	-29.54	1446.56	-28.50	69.07	-6.66	.22	552.01	51288.1	.0	.0
2.1	242.98	-34.74	1443.57	-31.37	67.25	-7.41	.22	576.27	59962.7	.0	.0
2.2	239.30	-39.74	1440.32	-33.94	65.25	-8.16	.22	600.15	67860.4	.0	.0
2.3	235.18	-43.50	1436.80	-36.51	63.01	-8.93	.21	623.50	74916.0	.0	.0
2.4	230.68	-47.09	1433.06	-38.99	60.63	-9.71	.21	646.58	81094.1	.0	.0
2.5	225.85	-49.00	1429.08	-41.1[illegible]	58.13	-10.51	.20	669.00	86383.4	.0	.0
2.6	220.74	-52.76	1424.89	-43.37	55.54	-11.32	.20	690.90	90794.6	.0	.0
2.7	215.48	-54.14	1420.41	-45.39	52.91	-12.16	.19	712.22	94356.9	.0	.0
2.8	210.90	-55.07	1415.70	-47.21	50.27	-12.99	.19	732.96	97115.1	.0	.0
2.9	204.42	-56.20	1410.90	-48.96	47.64	-13.86	.19	753.08	99125.3	.0	.0
3.0	198.70	-55.65	1406.02	-50.50	45.06	-14.74	.18	772.50	100452.0	.0	.0
3.1	193.14	-56.61	1400.80	-52.10	42.55	-15.64	.17	791.47	101166.8	.0	.0
3.2	187.52	-56.21	1395.67	-53.51	40.11	-16.50	.17	809.72	101335.0	.0	.0
3.3	181.95	-55.72	1390.21	-54.87	37.77	-17.54	.16	827.35	101074.2	.0	.0
3.4	176.62	-51.21	1384.67	-56.00	35.50	-18.51	.16	844.36	95215.4	.0	.0
3.5	171.78	-47.71	1379.00	-57.35	33.64	-19.51	.15	860.80	98996.0	.0	.0
3.6	167.15	-43.75	1373.81	-58.60	31.80	-20.54	.15	875.69	95303.5	.0	.0
3.7	162.94	-40.47	1367.29	-59.75	30.31	-21.54	.15	892.06	81075.8	.0	.0
3.8	155.04	-37.06	1361.28	-61.27	28.88	-22.64	.14	906.85	77260.1	.0	.0
3.9	155.94	-34.68	1355.06	-62.57	27.50	-23.72	.14	921.38	73810.7	.0	.0
4.0	152.10	-32.19	1348.74	-63.84	26.43	-24.81	.14	934.90	70688.3	.0	.0
4.1	149.01	-29.72	1342.30	-65.17	25.37	-25.91	.13	948.96	67858.6	.0	.0
4.2	146.18	-27.80	1335.73	-66.49	24.41	-27.04	.13	962.15	65291.9	.0	.0
4.3	143.51	-25.09	1329.03	-67.79	23.54	-28.16	.13	974.86	62962.1	.0	.0
4.4	141.06	-23.51	1322.20	-69.03	22.73	-29.30	.13	987.42	60846.3	.0	.0
4.5	138.80	-21.71	1315.24	-70.37	22.03	-30.44	.12	999.54	58924.2	.0	.0
4.6	136.71	-20.04	1308.15	-71.62	21.37	-31.54	.12	1011.39	57177.9	.0	.0
4.7	134.79	-18.47	1300.93	-72.90	20.78	-32.74	.12	1022.88	55591.6	.0	.0
4.8	133.02	-17.00	1293.58	-74.19	20.24	-33.89	.12	1033.97	54151.1	.0	.0
4.9	131.39	-15.62	1286.11	-75.43	19.75	-35.04	.12	1044.88	52843.8	.0	.0
5.0	129.89	-14.33	1278.51	-76.62	19.31	-36.19	.12	1055.46	51658.1	.0	.0
5.1	128.52	-13.12	1270.78	-77.93	18.91	-37.33	.12	1065.80	50584.0	.0	.0
5.2	127.26	-11.99	1262.93	-79.19	18.55	-38.47	.11	1075.88	49612.2	.0	.0
5.3	126.12	-10.93	1254.96	-80.39	18.22	-39.60	.11	1085.71	48736.4	.0	.0
5.4	125.07	-9.94	1246.89	-81.50	17.92	-40.72	.11	1095.20	47942.9	.0	.0
5.5	123.76	-17.01	1238.60	-82.54	17.44	-41.83	.11	1104.64	50657.0	.0	.0
5.6	121.78	-23.05	1230.38	-82.96	17.00	-42.94	.11	1113.60	70080.7	.0	.0
5.7	119.22	-28.82	1222.08	-82.87	16.30	-44.05	.11	1122.42	78978.2	.0	.0
5.8	116.19	-32.74	1213.92	-82.39	15.48	-45.17	.10	1130.79	86231.2	.0	.0
5.9	112.78	-35.00	1205.61	-81.57	14.50	-46.29	.10	1138.76	91820.7	.0	.0
6.0	109.11	-38.05	1197.51	-80.35	13.66	-47.43	.10	1146.32	95853.0	.0	.0
6.1	105.27	-39.28	1189.54	-78.97	12.72	-48.59	.09	1153.48	98445.0	.0	.0
6.2	101.34	-39.71	1181.79	-77.34	11.78	-49.74	.09	1160.21	99788.8	.0	.0
6.3	97.40	-39.48	1174.06	-75.63	10.89	-50.93	.09	1166.54	100089.3	.0	.0
6.4	93.51	-38.70	1166.58	-73.87	10.04	-52.13	.08	1172.48	99565.9	.0	.0
6.5	89.72	-37.42	1159.28	-71.98	9.25	-53.35	.08	1177.98	98349.6	.0	.0
6.6	86.06	-36.02	1152.17	-70.14	8.51	-54.50	.08	1183.13	966[illegible].7	.0	.0
6.7	82.56	-34.52	1145.23	-68.31	7.83	-55.89	.07	1187.95	94695.9	.0	.0
6.8	79.24	-32.60	1138.48	-66.57	7.22	-57.09	.07	1192.30	92427.6	.0	.0
6.9	76.10	-30.61	1131.91	-64.70	6.66	-58.36	.07	1196.51	90083.9	.0	.0
7.0	73.15	-28.70	1125.51	-63.11	6.15	-59.63	.07	1200.34	87708.5	.0	.0
7.1	70.38	-26.09	1119.27	-61.50	5.70	-60.90	.06	1203.86	85352.7	.0	.0
7.2	67.81	-25.01	1113.19	-59.97	5.29	-62.17	.06	1207.17	83046.1	.0	.0
7.3	65.41	-23.27	1107.26	-58.56	4.92	-63.44	.06	1210.28	80846.6	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	LC	L3	L4
7.4	63.18	-21.61	1101.47	-57.11	4.59	-64.69	.06	1213.00	78757.7	.0	.0
7.5	61.19	-18.20	1095.82	-55.87	4.31	-65.93	.06	1215.50	73022.0	.0	.0
7.6	59.52	-15.36	1090.23	-54.88	4.08	-67.18	.05	1217.90	69023.4	.0	.0
7.7	58.10	-13.00	1084.83	-54.00	3.89	-68.34	.05	1220.19	66649.3	.0	.0
7.8	56.90	-11.03	1079.47	-53.30	[illegible]	-69.49	.05	1222.29	63938.0	.0	.0
7.9	55.89	-9.36	1073.18	-52.72	[illegible]	-70.61	.05	1224.17	61683.0	.0	.0
8.0	55.02	-7.95	1068.49	-52.23	3.49	-71.68	.05	1225.96	59800.5	.0	.0
8.1	54.29	-6.76	1063.71	-51.84	3.40	-72.71	.05	1227.62	58224.5	.0	.0
8.2	53.66	-5.75	1058.[illegible]	-51.51	3.32	-73.70	.05	1229.18	56902.1	.0	.0
8.3	53.13	-4.89	1053.40	-51.26	3.25	-74.64	.05	1230.65	55790.4	.0	.0
8.4	52.68	-4.16	1048.28	-51.01	3.20	-75.54	.05	1231.98	54854.8	.0	.0
8.5	52.30	-3.55	1043.20	-50.85	3.15	-76.39	.05	1233.25	54066.6	.0	.0
8.6	51.97	-3.00	1038.12	-50.68	3.11	-77.20	.05	1234.44	53402.3	.0	.0
8.7	51.70	-2.55	1033.06	-50.56	3.08	-77.96	.05	1235.55	52842.3	.0	.0
8.8	51.46	-2.16	1028.01	-50.46	3.05	-78.68	.04	1236.59	52370.3	.0	.0
8.9	51.26	-1.84	1022.97	-50.38	3.03	-79.37	.05	1237.56	51972.7	.0	.0
9.0	51.09	-1.56	1017.93	-50.3[illegible]	3.01	-80.01	.05	1238.48	51637.9	.0	.0
9.1	50.95	-1.32	1012.90	-50.27	2.99	-80.62	.05	1239.34	51356.4	.0	.0
9.2	50.83	-1.11	1007.88	-50.23	2.98	-81.19	.05	1240.13	51119.9	.0	.0
9.3	50.72	-.94	1002.86	-50.20	2.97	-81.73	.05	1240.88	50921.5	.0	.0
9.4	50.49	-4.07	997.84	-50.05	2.94	-82.24	.05	1241.59	55853.8	.0	.0
9.5	49.96	-6.70	992.86	-49.56	2.88	-82.72	.04	1242.24	59993.5	.0	.0
9.6	49.20	-8.81	987.95	-48.85	2.79	-83.17	.04	1242.84	63313.2	.0	.0
9.7	48.25	-10.40	983.09	-47.95	2.69	-83.61	.04	1243.41	65839.0	.0	.0
9.8	47.17	-11.53	978.34	-46.91	2.57	-84.03	.04	1243.92	67639.8	.0	.0
9.9	45.99	-12.26	973.70	-45.77	2.44	-84.42	.04	1244.39	68792.6	.0	.0
10.0	44.75	-12.63	969.17	-44.57	2.31	-84.80	.04	1244.81	69409.3	.0	.0
10.1	43.61	-10.56	964.77	-43.48	2.20	-85.17	.04	1245.19	65910.6	.0	.0
10.2	42.67	-8.54	960.4[illegible]	-42.54	2.10	-85.52	.04	1245.54	63102.5	.0	.0
10.3	41.89	-7.06	956.2[illegible]	-41.78	2.03	-85.84	.04	1245.86	60831.1	.0	.0
10.4	41.25	-5.86	952.10	-41.15	1.97	-86.15	.04	1246.15	58981.6	.0	.0
10.5	40.71	-4.88	948.01	-40.64	1.92	-86.44	.04	1246.41	57466.0	.0	.0
10.6	40.26	-4.07	943.97	-40.20	1.87	-86.72	.04	1246.65	56223.0	.0	.0
10.7	39.89	-3.40	939.96	-39.84	1.84	-86.97	.04	1246.87	55195.4	.0	.0
10.8	39.58	-2.84	935.99	-39.55	1.81	-87.20	.04	1247.07	54344.9	.0	.0
10.9	39.32	-2.38	932.04	-39.28	1.79	-87.43	.04	1247.25	53637.8	.0	.0
11.0	39.10	-2.00	928.13	-39.07	1.77	-87.63	.04	1247.49	53049.8	.0	.0
11.1	38.92	-1.68	924.22	-38.89	1.75	-87.81	.03	1247.58	52529.6	.0	.0
11.2	38.53	-6.48	920.36	-38.59	1.72	-87.99	.03	1247.72	60165.3	.0	.0
11.3	37.70	-10.29	916.54	-37.68	1.66	-88.15	.03	1247.85	65950.4	.0	.0
11.4	36.56	-12.80	912.82	-36.58	1.58	-88.30	.03	1247.96	69855.5	.0	.0
11.5	35.23	-14.25	909.23	-35.21	1.44	-88.45	.03	1248.05	72109.8	.0	.0
11.6	33.74	-14.89	905.77	-33.78	1.37	-88.59	.03	1248.15	73029.4	.0	.0
11.7	32.32	-14.78	902.46	-32.31	1.31	-88.72	.03	1248.23	72954.5	.0	.0
11.8	30.88	-14.29	899.29	-30.88	1.10	-88.84	.03	1248.29	72195.9	.0	.0
11.9	29.51	3.43	896.27	-29.50	1.01	-88.96	.03	1248.39	71009.8	.0	.0
12.0	28.02	-12.49	893.38	-28.21	.92	-89.07	.03	1248.40	69592.0	.0	.0
12.1	27.17	-8.42	890.61	-27.17	.85	-89.17	.02	1248.44	63076.8	.0	.0
12.2	26.48	-5.49	887.92	-26.44	.81	-89.27	.02	1248.48	58517.2	.0	.0
12.3	26.04	-3.38	885.30	-26.04	.79	-89.35	.02	1248.51	55236.6	.0	.0
12.4	25.78	-1.89	882.70	-25.78	.77	-89.43	.02	1248.54	52861.1	.0	.0
12.5	25.65	-.65	880.13	-25.65	.76	-89.49	.02	1248.56	51005.0	.0	.0
12.6	25.63	.24	877.57	-25.6[illegible]	.76	-89.55	.02	1248.58	49612.6	.0	.0
12.7	25.61	-.79	875.01	-25.61	.76	-89.61	.02	1248.60	51219.8	.0	.0
12.8	25.44	-1.57	872.45	-25.44	.75	-89.65	.02	1248.62	52437.6	.0	.0
12.9	25.31	-2.34	869.91	-25.31	.74	-89.65	.02	1248.63	53294.8	.0	.0
13.0	25.06	-2.87	867.39	-25.04	.73	-89.73	.02	1248.64	53944.1	.0	.0
13.1	24.81	-2.86	864.89	-24.81	.72	-89.76	.02	1248.65	54439.5	.0	.0
13.2	24.58	-3.04	862.42	-24.59	.70	-89.79	.02	1248.66	54724.8	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	LP	L3	L4
13.3	24.21	-3.15	859.90	-24.81	.68	-39.82	.02	1248.67	58884.6	.0	.0
13.4	23.90	-3.13	857.98	-23.80	.66	-89.84	.02	1248.68	58955.7	.0	.0
13.5	23.59	-3.14	855.20	-23.50	.64	-89.86	.02	1248.68	58758.7	.0	.0
13.6	23.27	-3.16	852.86	-23.24	.63	-89.88	.02	1248.69	58404.8	.0	.0
13.7	22.91	-3.11	850.56	-22.99	.61	-89.89	.02	1248.69	58222.4	.0	.0
13.8	22.66	-3.00	848.26	-22.66	.60	-89.91	.02	1248.70	55714.3	.0	.0
13.9	22.51	.88	846.01	-22.51	.59	-89.92	.02	1248.70	48936.0	.0	.0
14.0	22.62	2.94	843.76	-22.29	.59	-89.93	.02	1248.70	46350.5	.0	.0
14.1	22.94	4.90	841.40	-22.94	.61	-89.94	.02	1248.71	53471.1	.0	.0
14.2	23.45	5.41	838.18	-23.42	.64	-89.95	.02	1248.71	40869.7	.0	.0
14.3	23.92	4.84	836.84	-23.91	.66	-89.95	.02	1248.71	43418.6	.0	.0
14.4	24.24	2.44	834.30	-24.24	.68	-89.96	.02	1248.71	45426.2	.0	.0
14.5	24.33	1.04	832.48	-24.57	.70	-89.96	.02	1248.71	47087.3	.0	.0
14.6	24.67	1.07	829.48	-24.67	.71	-89.97	.02	1248.72	48539.2	.0	.0
14.7	24.75	.41	827.42	-24.78	.71	-89.97	.02	1248.72	48776.9	.0	.0
14.8	24.77	-.10	824.84	-24.79	.71	-89.98	.02	1248.72	50142.6	.0	.0
14.9	24.75	-.40	822.06	-24.76	.71	-89.98	.02	1248.72	50758.5	.0	.0
15.0	24.68	-.79	819.50	-24.68	.71	-89.98	.02	1248.72	51222.4	.0	.0
15.1	24.59	-1.02	817.19	-24.50	.70	-89.98	.02	1248.72	51570.6	.0	.0
15.2	24.48	-1.15	814.68	-24.48	.70	-89.99	.02	1248.72	51828.0	.0	.0
15.3	24.36	-1.30	812.29	-24.36	.69	-89.99	.02	1248.72	52014.3	.0	.0
15.4	24.24	-1.40	809.90	-24.2	.68	-89.99	.02	1248.72	52149.8	.0	.0
15.5	24.09	-1.44	807.51	-24.09	.67	-89.99	.02	1248.72	52239.1	.0	.0
15.6	23.94	-1.48	804.94	-23.94	.67	-89.99	.02	1248.72	52290.3	.0	.0
15.7	23.80	-1.50	802.60	-23.82	.66	-89.99	.02	1248.72	52321.7	.0	.0
15.8	23.65	-1.51	800.23	-23.65	.65	-89.99	.02	1248.72	52334.3	.0	.0
15.9	23.50	-1.50	797.87	-23.50	.64	-89.99	.02	1248.72	52333.0	.0	.0
16.0	23.35	-1.50	795.52	-23.35	.63	-90.00	.02	1248.72	52321.2	.0	.0
16.1	23.20	-1.48	793.10	-23.20	.63	-90.00	.02	1248.72	52301.6	.0	.0
16.2	23.06	-1.47	790.88	-23.06	.62	-90.00	.02	1248.72	52277.0	.0	.0
16.3	22.91	-1.45	788.54	-22.91	.61	-90.00	.02	1248.72	52248.2	.0	.0
16.4	22.77	-1.43	786.30	-22.77	.60	-90.00	.02	1248.72	52216.9	.0	.0
16.5	22.63	-1.41	784.04	-22.63	.59	-90.00	.02	1248.72	52183.8	.0	.0
16.6	22.50	-1.39	781.77	-22.50	.59	-90.00	.02	1248.72	52149.7	.0	.0
16.7	22.36	-1.36	779.55	-22.36	.58	-90.00	.02	1248.72	52115.1	.0	.0
16.8	22.23	-1.34	777.30	-22.23	.57	-90.00	.02	1248.72	52080.4	.0	.0
16.9	22.09	-1.32	775.08	-22.09	.57	-90.00	.02	1248.72	52045.9	.0	.0
17.0	21.96	-1.30	772.84	-21.96	.56	-90.00	.02	1248.72	52011.8	.0	.0
17.1	21.84	-1.28	770.68	-21.84	.55	-90.00	.02	1248.72	51978.1	.0	.0
17.2	21.71	-1.26	768.51	-21.71	.55	-90.00	.02	1248.72	51945.1	.0	.0
17.3	21.59	-1.23	766.30	-21.59	.54	-90.00	.02	1248.72	51912.8	.0	.0
17.4	21.47	-1.21	764.10	-21.47	.54	-90.00	.02	1248.72	51881.1	.0	.0
17.5	21.35	-1.19	762.04	-21.35	.53	-90.00	.02	1248.72	51850.2	.0	.0
17.6	21.24	-1.17	759.85	-21.24	.53	-90.00	.02	1248.72	51820.1	.0	.0
17.7	21.12	-1.14	757.80	-21.12	.52	-90.00	.02	1248.72	51790.7	.0	.0
17.8	21.01	-1.14	755.60	-21.01	.51	-90.00	.02	1248.72	51762.1	.0	.0
17.9	20.90	-1.12	753.50	-20.90	.51	-90.00	.02	1248.72	51734.1	.0	.0
18.0	20.79	-1.10	751.51	-20.79	.50	-90.00	.02	1248.72	51706.9	.0	.0
18.1	20.68	-1.08	749.43	-20.68	.50	-90.00	.02	1248.72	51680.5	.0	.0
18.2	20.58	-1.07	747.40	-20.58	.49	-90.00	.02	1248.72	51654.6	.0	.0
18.3	20.47	-1.06	745.35	-20.47	.49	-90.00	.02	1248.72	51629.4	.0	.0
18.4	20.37	-1.03	743.28	-20.37	.48	-90.00	.02	1248.72	51604.8	.0	.0
18.5	20.27	-1.02	741.24	-20.27	.48	-90.00	.02	1248.72	51580.9	.0	.0
18.6	20.17	-1.00	739.23	-20.17	.47	-90.00	.02	1248.72	51557.0	.0	.0
18.7	20.09	-.88	737.21	-20.09	.47	-90.00	.02	1248.72	51004.0	.0	.0
18.8	20.03	-.50	735.20	-20.03	.47	-90.00	.02	1248.72	50600.1	.0	.0
18.9	20.00	-.29	733.20	-20.00	.47	-90.00	.02	1248.72	50317.2	.0	.0
19.0	19.98	-.11	731.20	-19.99	.46	-90.00	.02	1248.72	50194.9	.0	.0
19.1	19.94	.02	729.20	-19.90	.46	-90.00	.02	1248.72	49954.8	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	L2	LS	LP
19.2	19.99	.14	727.80	-19.94	.47	-90.00	.02	1248.72	40868.9	.0	.0
19.3	20.01	.15	725.80	-20.01	.47	-90.00	.02	1248.72	40780.0	.0	.0
19.4	20.02	.19	723.80	-20.02	.47	-90.00	.02	1248.72	40708.0	.0	.0
19.5	20.04	.21	721.80	-20.04	.47	-90.00	.02	1248.72	40646.6	.0	.0
19.6	20.06	.23	719.10	-20.06	.47	-90.00	.02	1248.72	40635.2	.0	.0
19.7	20.08	.25	717.10	-20.08	.47	-90.00	.02	1248.72	40612.0	.0	.0
19.8	20.11	.26	715.10	-20.11	.47	-90.00	.02	1248.72	40594.7	.0	.0
19.9	20.14	.27	713.16	-20.14	.47	-90.00	.02	1248.72	40581.6	.0	.0
20.0	20.17	.27	711.11	-20.17	.47	-90.00	.02	1248.72	40571.5	.0	.0
20.1	20.19	.28	709.13	-20.19	.47	-90.00	.02	1248.72	40563.7	.0	.0
20.2	20.22	.28	707.11	-20.22	.48	-90.00	.02	1248.72	40557.4	.0	.0
20.3	20.25	.28	705.09	-20.25	.48	-90.00	.02	1248.72	40552.2	.0	.0
20.4	20.28	.29	703.08	-20.28	.48	-90.00	.02	1248.72	40548.1	.0	.0
20.5	20.30	.29	701.05	-20.30	.48	-90.00	.02	1248.72	40544.5	.0	.0
20.6	20.33	.29	699.00	-20.33	.48	-90.00	.02	1248.72	40541.3	.0	.0
20.7	20.36	.30	696.97	-20.36	.48	-90.00	.02	1248.72	40538.6	.0	.0
20.8	20.39	.30	694.92	-20.39	.48	-90.00	.02	1248.72	40535.7	.0	.0
20.9	20.42	.30	692.88	-20.42	.48	-90.00	.02	1248.72	40533.2	.0	.0
21.0	20.45	.30	690.84	-20.45	.49	-90.00	.02	1248.72	40530.8	.0	.0
21.1	20.48	.30	688.78	-20.48	.49	-90.00	.02	1248.72	40529.5	.0	.0
21.2	20.51	.30	686.73	-20.51	.49	-90.00	.02	1248.72	40526.7	.0	.0
21.3	20.54	.30	684.66	-20.54	.49	-90.00	.02	1248.72	40524.0	.0	.0
21.4	20.57	.31	682.60	-20.57	.49	-90.00	.02	1248.72	40521.8	.0	.0
21.5	20.60	.31	680.54	-20.60	.49	-90.00	.02	1248.72	40519.6	.0	.0
21.6	20.63	.31	678.47	-20.63	.50	-90.00	.02	1248.72	40517.4	.0	.0
21.7	20.66	.31	676.40	-20.66	.50	-90.00	.02	1248.72	40515.2	.0	.0
21.8	20.69	.31	674.32	-20.69	.50	-90.00	.02	1248.72	40513.0	.0	.0
21.9	20.72	.31	672.24	-20.72	.50	-90.00	.02	1248.72	40510.8	.0	.0
22.0	20.75	.31	670.16	-20.75	.50	-90.00	.02	1248.72	40508.6	.0	.0
22.1	20.78	.32	668.08	-20.78	.50	-90.00	.02	1248.72	40506.4	.0	.0
22.2	20.81	.32	665.99	-20.81	.50	-90.00	.02	1248.72	40504.1	.0	.0
22.3	20.85	.32	663.90	-20.85	.51	-90.00	.02	1248.72	40501.8	.0	.0
22.4	20.88	.32	661.80	-20.88	.51	-90.00	.02	1248.72	40499.5	.0	.0
22.5	20.91	.32	659.70	-20.91	.51	-90.00	.02	1248.72	40497.3	.0	.0
22.6	20.94	.32	657.60	-20.94	.51	-90.00	.02	1248.72	40495.0	.0	.0
22.7	20.97	.32	655.49	-20.97	.51	-90.00	.02	1248.72	40492.6	.0	.0
22.8	21.00	.33	653.38	-21.00	.51	-90.00	.02	1248.72	40490.3	.0	.0
22.9	21.04	.33	651.26	-21.04	.52	-90.00	.02	1248.72	40487.9	.0	.0
23.0	21.07	.33	649.15	-21.07	.52	-90.00	.02	1248.72	40485.5	.0	.0
23.1	21.10	.33	647.02	-21.10	.52	-90.00	.02	1248.72	40483.1	.0	.0
23.2	21.13	.33	644.90	-21.13	.52	-90.00	.02	1248.72	40480.7	.0	.0
23.3	21.17	.33	642.77	-21.17	.52	-90.00	.02	1248.72	40478.1	.0	.0
23.4	21.20	.33	640.60	-21.20	.53	-90.00	.02	1248.72	40475.8	.0	.0
23.5	21.23	.34	638.50	-21.23	.53	-90.00	.02	1248.72	40473.4	.0	.0
23.6	21.27	.34	636.36	-21.27	.53	-90.00	.02	1248.72	40470.9	.0	.0
23.7	21.30	.34	634.21	-21.30	.53	-90.00	.02	1248.72	40468.4	.0	.0
23.8	21.33	.34	632.06	-21.33	.53	-90.00	.02	1248.72	40465.9	.0	.0
23.9	21.37	.34	630.20	-21.37	.53	-90.00	.02	1248.72	40463.2	.0	.0
24.0	21.40	.34	628.11	-21.40	.53	-90.00	.02	1248.72	40460.7	.0	.0
24.1	21.43	.35	625.90	-21.43	.54	-90.00	.02	1248.72	40458.1	.0	.0
24.2	21.47	.35	623.80	-21.47	.54	-90.00	.02	1248.72	40455.5	.0	.0
24.3	21.50	.35	621.60	-21.50	.54	-90.00	.02	1248.72	40452.8	.0	.0
24.4	21.54	.35	619.50	-21.54	.54	-90.00	.02	1248.72	40450.2	.0	.0
24.5	21.57	.35	617.30	-21.57	.54	-90.00	.02	1248.72	40447.3	.0	.0
24.6	21.61	.35	615.21	-21.61	.54	-90.00	.02	1248.72	40444.6	.0	.0
24.7	21.64	.36	613.08	-21.64	.55	-90.00	.02	1248.72	40442.0	.0	.0
24.8	21.68	.36	610.88	-21.68	.55	-90.00	.02	1248.72	40439.3	.0	.0
24.9	21.71	.36	608.71	-21.71	.55	-90.00	.02	1248.72	40436.5	.0	.0
25.0	21.75	.36	606.54	-21.75	.55	-90.00	.02	1248.72	40433.7	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	L2	L3	L6
25.1	21.78	.36	604.36	-21.78	.55	-90.00	.02	1248.79	49430.9	.0	.0
25.2	21.82	.37	602.18	-21.82	.56	-90.00	.02	1248.79	49428.1	.0	.0
25.3	21.86	.37	600.00	-21.86	.56	-90.00	.02	1248.79	49425.2	.0	.0
25.4	21.89	.37	597.81	-21.89	.56	-90.00	.02	1248.79	49422.3	.0	.0
25.5	21.93	.37	595.62	-21.93	.56	-90.00	.02	1248.79	49419.4	.0	.0
25.6	21.96	.37	593.43	-21.96	.56	-90.00	.02	1248.79	49416.5	.0	.0
25.7	22.00	.37	591.23	-22.00	.57	-90.00	.02	1248.79	49413.5	.0	.0
25.8	22.04	.38	589.03	-22.04	.57	-90.00	.02	1248.79	49410.5	.0	.0
25.9	22.08	.38	586.82	-22.08	.57	-90.00	.02	1248.79	49407.5	.0	.0
26.0	22.11	.38	584.61	-22.11	.57	-90.00	.02	1248.79	49404.5	.0	.0
26.1	22.15	.38	582.40	-22.15	.57	-90.00	.02	1248.79	49401.4	.0	.0
26.2	22.19	.38	580.18	-22.19	.58	-90.00	.02	1248.79	49398.3	.0	.0
26.3	22.23	.39	577.96	-22.23	.58	-90.00	.02	1248.79	49395.2	.0	.0
26.4	22.27	.39	575.74	-22.27	.58	-90.00	.02	1248.79	49392.1	.0	.0
26.5	22.30	.39	573.51	-22.30	.58	-90.00	.02	1248.79	49388.9	.0	.0
26.6	22.34	.39	571.28	-22.34	.58	-90.00	.02	1248.79	49385.7	.0	.0
26.7	22.38	.39	569.04	-22.38	.59	-90.00	.02	1248.79	49382.5	.0	.0
26.8	22.42	.40	566.80	-22.42	.59	-90.00	.02	1248.79	49379.2	.0	.0
26.9	22.46	.40	564.56	-22.46	.59	-90.00	.02	1248.79	49375.9	.0	.0
27.0	22.50	.40	562.31	-22.50	.59	-90.00	.02	1248.79	49372.6	.0	.0
27.1	22.54	.40	560.06	-22.54	.59	-90.00	.02	1248.79	49369.3	.0	.0
27.2	22.58	.41	557.80	-22.58	.60	-90.00	.02	1248.79	49365.9	.0	.0
27.3	22.62	.41	555.54	-22.62	.60	-90.00	.02	1248.79	49362.5	.0	.0
27.4	22.66	.41	553.28	-22.66	.60	-90.00	.02	1248.79	49359.1	.0	.0
27.5	22.70	.41	551.01	-22.70	.60	-90.00	.02	1248.79	49355.6	.0	.0
27.6	22.74	.41	548.74	-22.74	.60	-90.00	.02	1248.79	49352.1	.0	.0
27.7	22.78	.42	546.46	-22.78	.61	-90.00	.02	1248.79	49348.6	.0	.0
27.8	22.82	.42	544.18	-22.82	.61	-90.00	.02	1248.79	49345.0	.0	.0
27.9	22.86	.42	541.90	-22.86	.61	-90.00	.02	1248.79	49341.4	.0	.0
28.0	22.90	.42	539.61	-22.90	.61	-90.00	.02	1248.79	49337.8	.0	.0
28.1	22.94	.43	537.32	-22.94	.62	-90.00	.02	1248.79	49334.2	.0	.0
28.2	22.98	.43	535.03	-22.98	.62	-90.00	.02	1248.79	49330.5	.0	.0
28.3	23.03	.43	532.73	-23.03	.62	-90.00	.02	1248.79	49326.7	.0	.0
28.4	23.07	.43	530.43	-23.07	.62	-90.00	.02	1248.79	49323.0	.0	.0
28.5	23.11	.44	528.11	-23.11	.63	-90.00	.02	1248.79	49319.2	.0	.0
28.6	23.16	.44	525.80	-23.16	.63	-90.00	.02	1248.79	49315.4	.0	.0
28.7	23.20	.44	523.48	-23.20	.63	-90.00	.02	1248.79	49311.5	.0	.0
28.8	[illegible]	.44	521.16	-23.2[illegible]	.63	-90.0[illegible]	.02	1248.79	49307.6	.0	.0
28.9	23.29	.4[illegible]	518.83	-23.29	.63	-90.0[illegible]	.02	1248.79	49303.7	.0	.0
29.0	23.33	.4[illegible]	516.[illegible]	-23.33	.64	-90.0[illegible]	.02	1248.79	49299.7	.0	.0
29.1	23.38	.4[illegible]	514.16	-23.38	.64	-90.0[illegible]	.02	1248.79	49295.7	.0	.0
29.2	23.42	.4[illegible]	511.8[illegible]	-23.4[illegible]	.64	-90.0[illegible]	.02	1248.79	49291.6	.0	.0
29.3	23.47	.4[illegible]	509.40	-23.4[illegible]	.64	-90.00	.02	1248.79	49287.5	.0	.0
29.4	23.51	.46	507.17	-23.5[illegible]	.65	-90.00	.02	1248.79	49283.4	.0	.0
29.5	23.5[illegible]	.46	504.70	-23.5[illegible]	.65	-90.00	.02	1248.79	49279.3	.0	.0
29.6	23.6[illegible]	.46	502.4[illegible]	-23.6[illegible]	.65	-90.00	.02	1248.79	49275.0	.0	.0
29.7	23.66	.47	500.06	-23.66	.66	-90.00	.02	1248.79	49270.7	.0	.0
29.8	23.70	.47	497.60	-23.70	.66	-90.00	.02	1248.79	49266.4	.0	.0
29.9	23.74	.47	495.3[illegible]	-23.74	.66	-90.00	.02	1248.79	49262.1	.0	.0
30.0	23.79	.47	492.94	-23.79	.66	-90.00	.02	1248.79	49257.7	.0	.0
30.1	23.84	.48	490.56	-23.84	.67	-90.00	.02	1248.79	49253.3	.0	.0
30.2	23.88	.36	488.17	-23.88	.67	-90.00	.02	1248.79	49429.2	.0	.0
30.3	23.91	.28	485.70	-23.91	.67	-90.00	.02	1248.79	49564.8	.0	.0
30.4	23.93	.21	483.30	-23.93	.67	-90.00	.02	1248.79	49668.7	.0	.0
30.5	23.96	.16	481.00	-23.96	.67	-90.00	.02	1248.79	49748.4	.0	.0
30.6	23.97	.12	478.60	-23.97	.67	-90.00	.02	1248.79	49809.4	.0	.0
30.7	23.98	.09	476.21	-23.98	.67	-90.00	.02	1248.79	49858.2	.0	.0
30.8	23.98	.07	473.81	-23.98	.67	-90.00	.02	1248.79	49892.0	.0	.0
30.9	23.99	.05	471.41	-23.99	.67	-90.00	.02	1248.79	49919.4	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	L2	L3	L4
31.0	23.99	.04	469.01	-23.90	.67	-90.00	.02	1248.79	49940.3	.0	.0
31.1	24.00	.02	466.61	-24.00	.68	-90.00	.02	1248.72	49956.9	.0	.0
31.2	24.00	.02	464.21	-24.00	.68	-90.00	.02	1248.72	49968.6	.0	.0
31.3	24.00	.01	461.81	-24.00	.68	-90.00	.02	1248.79	49978.0	.0	.0
31.4	24.00	.01	459.41	-24.00	.68	-90.00	.02	1248.72	49985.2	.0	.0
31.5	24.00	.00	457.01	-24.00	.68	-90.00	.02	1248.72	49990.7	.0	.0
31.6	24.00	.00	454.61	-24.00	.68	-90.00	.02	1248.72	49996.9	.0	.0
31.7	24.00	-.00	452.21	-24.00	.68	-90.00	.02	1248.72	49999.1	.0	.0
31.8	24.00	-.00	449.81	-24.00	.68	-90.00	.02	1248.72	50000.6	.0	.0
31.9	24.00	-.00	447.41	-24.00	.68	-90.00	.02	1248.72	50002.5	.0	.0
32.0	24.00	-.01	445.01	-24.00	.68	-90.00	.02	1248.72	50003.9	.0	.0
32.1	24.00	-.01	442.61	-24.00	.68	-90.00	.02	1248.72	50005.0	.0	.0
32.2	24.00	-.01	440.21	-24.00	.68	-90.00	.02	1248.72	50005.9	.0	.0
32.3	24.00	-.01	437.81	-24.00	.68	-90.00	.02	1248.72	50006.5	.0	.0
32.4	24.00	-.01	435.41	-24.00	.68	-90.00	.02	1248.72	50007.0	.0	.0
32.5	24.00	-.01	433.01	-24.00	.68	-90.00	.02	1248.72	50007.4	.0	.0
32.6	24.00	-.01	430.61	-24.00	.68	-90.00	.02	1248.72	50007.7	.0	.0
32.7	24.00	-.01	428.21	-24.00	.68	-90.00	.02	1248.72	50007.9	.0	.0
32.8	24.00	-.01	425.81	-24.00	.68	-90.00	.02	1248.72	50008.0	.0	.0
32.9	23.99	-.01	423.41	-23.99	.68	-90.00	.02	1248.72	50008.2	.0	.0
33.0	23.99	-.01	421.01	-23.99	.68	-90.00	.02	1248.72	50008.3	.0	.0
33.1	23.99	-.01	418.61	-23.99	.68	-90.00	.02	1248.72	50008.3	.0	.0
33.2	23.99	-.01	416.21	-23.99	.68	-90.00	.02	1248.72	50008.4	.0	.0
33.3	23.99	-.01	413.81	-23.99	.68	-90.00	.02	1248.72	50008.4	.0	.0
33.4	23.99	-.01	411.41	-23.99	.68	-90.00	.02	1248.72	50008.5	.0	.0
33.5	23.99	-.01	409.02	-23.99	.68	-90.00	.02	1248.72	50008.5	.0	.0
33.6	23.99	-.01	406.62	-23.99	.68	-90.00	.02	1248.72	50008.5	.0	.0
33.7	23.99	-.01	404.22	-23.99	.68	-90.00	.02	1248.72	50008.5	.0	.0
33.8	23.99	-.01	401.82	-23.99	.68	-90.00	.02	1248.72	50008.5	.0	.0
33.9	23.99	-.01	399.42	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.0	23.99	-.01	397.02	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.1	23.98	-.01	394.62	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.2	23.98	-.01	392.22	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.3	[illegible]	-.01	389.83	-23.99	.68	-90.00	.02	1248.72	50008.5	.0	.0
34.4	[illegible]	-.01	387.43	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.5	23.98	-.01	385.03	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.6	23.98	-.01	382.63	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.7	23.98	-.01	380.24	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.8	23.98	-.01	377.84	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
34.9	23.98	-.01	[illegible]	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.0	23.98	-.01	373.04	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.1	23.98	-.01	370.64	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.2	23.97	-.01	368.25	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.3	23.97	-.01	365.85	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.4	23.97	-.01	363.45	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.5	23.97	-.01	361.06	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.6	23.97	-.01	358.66	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.7	23.97	-.01	356.24	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.8	23.97	-.01	353.84	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
35.9	23.97	-.01	351.46	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.0	23.97	-.01	349.06	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.1	23.97	-.01	346.67	-23.99	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.2	23.97	-.01	344.27	-23.97	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.3	23.97	-.01	341.88	-23.97	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.4	23.96	-.01	339.48	-23.96	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.5	23.96	-.01	337.09	-23.96	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.6	23.96	-.01	334.69	-23.96	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.7	23.96	-.01	332.39	-23.96	.68	-90.00	.02	1248.72	50008.6	.0	.0
36.8	23.96	-.01	329.90	-23.96	.68	-90.00	.02	1248.72	50008.6	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	L2	L3	L4
36.9	23.96	-.01	327.50	-23.96	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.0	23.96	-.01	325.11	-23.96	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.1	23.96	-.01	322.71	-23.96	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.2	23.96	-.01	320.32	-23.96	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.3	23.96	-.01	317.92	-23.96	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.4	23.96	-.01	315.52	-23.96	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.5	23.96	-.01	313.13	-23.96	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.6	23.95	-.01	310.73	-23.95	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.7	23.95	-.01	308.34	-23.95	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.8	23.95	-.01	305.94	-23.95	.68	-90.00	.02	1248.79	50008.6	.0	.0
37.9	23.95	-.01	303.55	-23.95	.68	-90.00	.02	1248.79	50008.6	.0	.0
38.0	23.95	-.01	301.15	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.1	23.95	-.01	298.76	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.2	23.95	-.01	296.36	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.3	23.95	-.01	293.97	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.4	23.95	-.01	291.57	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.5	23.95	-.01	289.18	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.6	23.95	-.01	286.78	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.7	23.95	-.01	284.39	-23.95	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.8	23.94	-.01	281.99	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
38.9	23.94	-.01	279.60	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.0	23.94	-.01	277.21	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.1	23.94	-.01	274.81	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.2	23.94	-.01	272.42	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.3	23.94	-.01	270.02	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.4	23.94	-.01	267.63	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.5	23.94	-.01	265.23	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.6	23.94	-.01	262.84	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.7	23.94	-.01	260.45	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.8	23.94	-.01	258.05	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
39.9	23.94	-.01	255.66	-23.94	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.0	23.93	-.01	253.27	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.1	23.93	-.01	250.87	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.2	23.93	-.01	248.48	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.3	23.93	-.01	246.08	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.4	23.93	-.01	243.69	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.5	23.93	-.01	241.30	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.6	23.93	-.01	238.91	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.7	23.93	-.01	236.51	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.8	23.93	-.01	234.12	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
40.9	23.93	-.01	231.73	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.0	23.93	-.01	229.34	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.1	23.93	-.01	226.94	-23.93	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.2	23.92	-.01	224.55	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.3	23.92	-.01	222.16	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.4	23.92	-.01	219.77	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.5	23.92	-.01	217.37	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.6	23.92	-.01	214.98	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.7	23.92	-.01	212.59	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.8	23.92	-.01	210.20	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
41.9	23.92	-.01	207.81	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.0	23.92	-.01	205.41	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.1	23.92	-.01	203.02	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.2	23.92	-.01	200.63	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.3	23.92	-.01	198.24	-23.92	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.4	23.91	-.01	195.85	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.5	23.91	-.01	193.46	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.6	23.91	-.01	191.07	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.7	23.91	-.01	188.67	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	L2	L3	L4
42.8	23.91	-.01	186.28	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
42.9	23.91	-.01	183.89	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.0	23.91	-.01	181.50	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.1	23.91	-.01	179.11	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.2	23.91	-.01	176.72	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.3	23.91	-.01	174.33	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.4	23.91	-.01	171.94	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.5	23.91	-.01	169.55	-23.91	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.6	23.90	-.01	167.16	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.7	23.90	-.01	164.77	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.8	23.90	-.01	162.38	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
43.9	23.90	-.01	159.99	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.0	23.90	-.01	157.60	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.1	23.90	-.01	155.21	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.2	23.90	-.01	152.82	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.3	23.90	-.01	150.43	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.4	23.90	-.01	148.04	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.5	23.90	-.01	145.65	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.6	23.90	-.01	143.26	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.7	23.90	-.01	140.87	-23.90	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.8	23.89	-.01	138.48	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
44.9	23.89	-.01	136.09	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
45.0	23.89	-.01	133.70	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
45.1	23.89	-.01	131.31	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
45.2	23.89	-.01	128.92	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
45.3	23.89	-.01	126.53	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
45.4	23.89	-.01	124.14	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
45.5	23.89	-.01	121.75	-23.89	.68	-90.00	.02	1248.79	50008.4	.0	.0
45.6	23.89	-.01	119.37	-23.89	.68	-90.00	.02	1248.79	50008.4	.0	.0
45.7	23.89	-.01	116.98	-23.89	.68	-90.00	.02	1248.79	50008.4	.0	.0
45.8	23.89	-.01	114.59	-23.89	.68	-90.00	.02	1248.79	50008.4	.0	.0
45.9	23.89	-.01	112.20	-23.89	.68	-90.00	.02	1248.79	50008.5	.0	.0
46.0	23.88	-.01	109.81	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.1	23.88	-.01	107.42	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.2	23.88	-.01	105.03	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.3	23.88	-.01	102.64	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.4	23.88	-.01	100.26	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.5	23.88	-.01	97.87	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.6	23.88	-.01	95.48	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.7	23.88	-.01	93.09	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.8	23.88	-.01	90.71	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
46.9	23.88	-.01	88.32	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.0	23.88	-.01	85.93	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.1	23.88	-.01	83.54	-23.88	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.2	23.87	-.01	81.16	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.3	23.87	-.01	78.77	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.4	23.87	-.01	76.38	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.5	23.87	-.01	73.99	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.6	23.87	-.01	71.61	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.7	23.87	-.01	69.22	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.8	23.87	-.01	66.83	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
47.9	23.87	-.01	64.45	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
48.0	23.87	-.01	62.06	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
48.1	23.87	-.01	59.67	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
48.2	23.87	-.01	57.29	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
48.3	23.87	-.01	54.90	-23.87	.68	-90.00	.02	1248.79	50008.4	.0	.0
48.4	23.86	-.01	52.51	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
48.5	23.86	-.01	50.13	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
48.6	23.86	-.01	47.74	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0

TIME	VELOCITY	ACCELERATION	ALTITUDE	RATE OF CLIMB	DYNAMIC PRESSURE	PATH ANGLE	MACH NO.	RANGE	L7	L9	L8
48.7	23.86	-.01	45.35	-23.86	.68	-90.04	.02	1248.79	50008.4	.0	.0
48.8	23.86	-.01	42.97	-23.86	.68	-90.02	.02	1248.79	50008.4	.0	.0
48.9	23.86	-.01	40.58	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.0	23.86	-.01	38.20	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.1	23.86	-.01	35.81	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.2	23.86	-.01	33.42	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.3	23.86	-.01	31.04	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.4	23.86	-.01	28.65	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.5	23.86	-.01	26.27	-23.86	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.6	23.85	-.01	23.88	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.7	23.85	-.01	21.50	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.8	23.85	-.01	19.11	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
49.9	23.85	-.01	16.73	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
50.0	23.85	-.01	14.34	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
50.1	23.85	-.01	11.96	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
50.2	23.85	-.01	9.57	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
50.3	23.85	-.01	7.19	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
50.4	23.85	-.01	4.80	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
50.5	23.85	-.01	2.42	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0
50.6	23.85	-.01	.03	-23.85	.68	-90.00	.02	1248.79	50008.4	.0	.0

ALTITUDE IS LESS THAN STOP ALTITUDE.

50.6	23.85	-.01	-.21	-23.85	.68	-90.01	.02	1248.79	50008.4	.0	.0

I= 3 MIN= -0 MAX= 1457

I= 9 MIN= 0 MAX=101375

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13. ABSTRACT

This report covers the direct design aspects of the selected prototype cargo recovery assembly for airdropping heavy unit loads in the order of 50,000 pounds.

The detailed design of the components is covered as well as stress analysis to determine the margins of safety for the materials selected. Material lists and weights for the components are provided. Laboratory testing of individual components and strength efficiency of stitch patterns are shown.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Design	8					
Fabrication	8					
Cluster parachutes	9					
Aerial delivery	4		4			
Airdrop operations	4		4			
Clustering			8			
Parachutes			9			

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